CLINICAL RESEARCH

Changes over time in the prevalence and treatment of cardiovascular risk factors, and contributions to time trends in coronary mortality over 25 years in the Lille urban area (northern France)

Évolution des prévalences et de la prise en charge des facteurs de risque cardiovasculaires et leurs contributions à la baisse de la mortalité coronarienne sur 25 ans dans la zone urbaine de Lille

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KEYWORDS
Risk factor; Coronary disease; Epidemiology

Summary
Background. — The long-term collection of population-based data should improve our knowledge of the contribution of trend in cardiovascular risk factors to the steady fall in mortality associated with coronary heart disease in high-income countries.

Abbreviations: BMI, body mass index; CHD, coronary heart disease; CI, confidence interval; DBP, diastolic blood pressure; INSEE, Institut national de la statistique et des études économiques; SBP, systolic blood pressure; SCORE, Systematic Coronary Risk Evaluation.

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**Background**

Cardiovascular disease death rates are falling in western, high-income countries. This fall coincides with declines in smoking and physiological risk factors, and improvements in medical care (including primary prevention and better treatment of acute events) [1]. Ten years of data from the MONICA project have enabled researchers to estimate that the decrease in the incidence of coronary heart events accounted for two-thirds of the decrease in coronary mortality in the 1980s, and that case fatality accounted for one third [2]. Long-term collection of population-based data is needed to better understand why the long-term decline in coronary heart disease (CHD) is continuing, and to what extent trends in known risk factors contribute to trends in CHD mortality. The city of Lille and the surrounding urban area (with a total of about 1 million inhabitants) is a MONICA project centre. Registration

**Aims.** — To assess long-term time trends in the prevalence of cardiovascular risk factors, estimated coronary heart disease risk and mortality between 1986 and 2013 in the Lille urban area (northern France).

**Methods.** — We studied representative samples of inhabitants of the Lille urban area (aged 40–64 years) in 1986–1988 (n = 860), 1995–1996 (n = 1021), 2005–2007 (n = 1021) and 2011–2013 (n = 1636), together with data from the Lille MONICA registry.

**Results.** — In men, the age-standardized prevalence fell between 1986 and 2013 from 70.5% to 42.5% for hypertension, from 71.1% to 58.3% for dyslipidaemia and from 44.1% to 24.7% for smoking (all p < 0.001). The prevalence of being overweight increased from 59.6% to 65.1% (p < 0.05). In women, the prevalences decreased from 56.6% to 34.3% for hypertension and from 60.9% to 42.2% for dyslipidaemia (both p < 0.001). The prevalences of smoking (17%) and being overweight (50%) were stable. The mean 10-year (95% confidence interval) predicted risk of fatal coronary heart disease (estimated with the Systematic Coronary Risk Evaluation equation) decreased by 2.02% (1.78–2.25%) per year for men and by 1.55% (1.32–1.78%) for women. The observed coronary mortality rate fell by 2.6% (2.2–3.0%) in men and 2.8% (1.9–3.6%) in women.

**Conclusions.** — Prevalences of main risk factors and estimated coronary mortality risk decreased concomitantly with the observed coronary mortality — indicating that primary prevention made a major contribution to the decrease in mortality.

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of CHD events and mortality is ongoing. Time trends in the prevalences of the main cardiovascular risk factors in the Lille urban area between 1986 and 2013 have been studied in four successive cross-sectional studies of the general population: MONICA1986–1988, MONICA1995–1996, Monitoring national du risque artériel (MONALISA2005–2007) and the Enquête littoral souffle air biologie environnement (ELISABET2011–2013) survey. These studies have enabled us to assess time trends in mortality and cardiovascular risk factors over 25 years or so.

The objectives of the present study were to assess time trends in the prevalence of the main modifiable cardiovascular risk factors, and to compare the time trends in the 10-year predicted risk of fatal CHD in the Lille urban area between 1986 and 2013 with the observed coronary mortality during the same period.

Methods
Population sample
The MONICA1986–1988, MONICA1995–1996, MONALISA2005–2007 and ELISABET2011–2013 [8] (ClinicalTrials.gov identifier, NCT02490553; local ethical committee [CPP Nord Ouest IV] identifier, 2010-A00065-34) cross-sectional surveys of the prevalence of cardiovascular risk factors in the Lille urban area shared similar methodologies [4–8]. In all studies, participants living in the Lille urban area were selected randomly from electoral rolls, and stratified by sex and age class. Participants aged 40–64 years were included in the present analysis.

To evaluate the sampling quality, we compared the distribution of the participants’ occupational categories in the MONALISA2005–2007 study and the ELISABET2011–2013 Study with authoritative data from the French National Institute of Statistics and Economic Studies (Institut national de la statistique et des études économiques [INSEE]) for 2007 and 2010 [9].

Definitions and measurements of cardiovascular risk factors
The four studies had similar methodologies. Each participant had a single meeting with a trained interviewer. For better acceptability, the meeting usually took place at the participant’s home. Analyses were done in a central laboratory. However, blood glucose concentration was not determined in the MONICA1986–1988 survey.

Arterial blood pressure was measured by two consecutive measurements of systolic blood pressure (SBP) and diastolic blood pressure (DBP) with a manual (MONICA1986–1988 and MONICA1995–1996) or automatic sphygmomanometer (MONALISA2005–2007 and ELISABET2011–2013). The time interval between the two measurements ranged from 5 to 20 minutes, depending on the study. The arithmetic mean of the two measurements was used for analysis in the first three surveys. In ELISABET2011–2013, a second blood pressure measurement was taken systematically only during the last third of the study period. Hypertension was defined as ongoing antihypertensive treatment or SBP ≥ 140 mmHg or DBP ≥ 90 mmHg. Diabetes mellitus was defined as ongoing antidiabetes treatment (oral medication or insulin) or a fasting blood glucose concentration ≥ 1.26 g/L. Dyslipidaemia was defined as ongoing cholesterol-lowering treatment or one or more abnormal fasting blood lipid values (total cholesterol ≥ 2.4 g/L, low-density lipoprotein cholesterol ≥ 1.6 g/L, high-density lipoprotein cholesterol < 0.4 g/L or blood triglycerides ≥ 2 g/L).

Participants were considered to be aware of their hypertension, dyslipidaemia or diabetes if they had already been diagnosed by a healthcare professional. Disease-aware participants taking medication were defined as treated cases. Controlled cases were defined as those with SBP < 140 mmHg and DBP < 90 mmHg and a haemoglobin A1c value < 7% (haemoglobin A1c was only measured in the MONALISA2005–07 and ELISABET2011–2013 studies). For dyslipidaemia, a lack of data prevented us from calculating the therapeutic threshold, and thus the proportion of controlled cases.

Weight was measured with a portable electronic scale, and height was measured with a stadiometer. Overweight was defined as a body mass index (BMI) between 25 and 29.9 kg/m², and obesity was defined as a BMI ≥ 30 kg/m². A participant was considered to be a current smoker if he/she was currently smoking at least one cigarette a day or had quit smoking in the last year. A participant was considered to be a former smoker if he/she had quit smoking at least 1 year previously.

Risk prediction of fatal event
The 10-year predicted risk of a fatal CHD event was calculated using the CHD part of the European Systematic Coronary Risk Evaluation (SCORE) tool [10], with the following items: age, sex, SBP, fasting total cholesterol concentration, current smoking and the population’s risk level (low or high). To evaluate the impact of obesity and diabetes on trends in CHD risk, we calculated the CHD part of the Framingham-Wilson [11] risk score for fatal or non-fatal coronary events (which includes BMI as a variable) for the latest three studies.

Secondary prevention data
In order to assess changes over time in practices related to secondary prevention, we used the data from the four EUROASPIRE studies (from 1993 to 2013) in our study area. The survey’s methodology has been described previously [12]. Briefly, we calculated the prevalence of cardiovascular risk factors in patients who had been hospitalised for a coronary event or procedure at least 6 months before the interview, in one of the four hospitals forming the French EUROASPIRE centre in the Lille urban area (Lille University Hospital in Lille, Dron Hospital in Tourcoing, Victor Provo Hospital in Roubaix and Saint Philibert Hospital in Lomme).

Cardiovascular risk factors were defined as follows: current smoking, obesity (BMI > 30 kg/m²), self-reported diabetes, undetected diabetes (fasting glucose ≥ 7 mmol/L in participants without known diabetes), raised blood pressure (SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg for participants without diabetes, and SBP ≥ 130 mmHg and/or DBP ≥ 80 mmHg for participants with diabetes), and low-density lipoprotein cholesterol ≥ 3 mmol/L.
Mortality data were provided by the Lille MONICA registry. Statistical methodology has been described previously [13].

Statistical analysis

Age-standardized prevalence, coronary mortality and means were calculated by using the age structure of the European population in 2013 as defined by the Eurostat task force [14]. The 95% confidence intervals (CIs) for prevalence were calculated in a bootstrap procedure using the bias-corrected and accelerated algorithm (5000 replicates). Time trends in prevalence were analysed with logistic regression models. Trends in the log-transformed average 10-year risk were analysed with a multiple linear regression model.

Age-standardized proportions of aware cases were calculated as the ratio between the age-standardized prevalence of aware cases in the overall population and the age-standardized prevalences of all cases. Similarly, the proportion of treated cases was the ratio between treated cases and aware cases. The proportion of controlled cases was the ratio between controlled cases and treated cases.

The mean decrease per year was calculated using a linear model adjusted for age after log transformation (for scores) or using Poisson regression (for mortality and incidence). Framingham-Wilson scores were available only until 1996, and so the mean decreases per year in CHD mortality in the SCORE risk score were calculated for the whole period and for the period beginning in 1996 (to enable comparison with the decrease in the Framingham-Wilson scores).

In order to quantify the possible influence of a discrepancy between the occupational category distribution in the sample and the distribution in census data, we standardized the prevalence against the 2013 European age distribution, and weighted it according to the local occupational category distribution, using the 2007 data for MONALISA2005–2007 and the 2011 data for ELISABET2011–2013 [9]. Data on occupational categories in the study area were not available for the two previous surveys.

All statistical analyses were performed with R software (R Development Core Team, version 3.0.0) and the boot package. A P value < 0.05 was considered to be statistically significant.

Results

Population

We included 860 participants from MONICA1986–1988, 1021 participants from MONICA1995–1996, 1021 from MONALISA2005–2007 and 1636 from ELISABET2011–2013 in our analysis. The cooperation rates were 69%, 76%, 70% and 54%, respectively (the denominator only includes eligible participants who had been contacted). The response rates were lower, with 66% in MONALISA2005–2007 and 32% in ELISABET2011–2013 (the denominator includes people who could not be contacted and therefore had unknown eligibility status). The occupational category distributions in MONALISA2005–2007 and ELISABET2011–2013 studies are shown in Supplementary Table S1. In both studies, mid-level professions were over-represented and blue-collar workers were under-represented. In the ELISABET2011–2013 study, male white-collar workers were over-represented and unemployed women were under-represented.

Prevalence of and trends in cardiovascular risk factors

The characteristics of the study population are summarized in Table 1. Mean blood pressure, glycaemia and blood lipid concentrations fell significantly. Mean BMI increased in men, but remained stable in women over that period.

Between 1986 and 2013, the prevalence of hypertension and dyslipidaemia decreased significantly in both sexes (Fig. 1). The proportion of current smokers decreased significantly only in men, and remained stable in women. In men, the prevalence of diabetes mellitus did not vary significantly between 1995–1996 and 2011–2013, but decreased significantly in women. The prevalence of being overweight or obese increased significantly in men, but not in women. Trends in obesity alone were not significant. The prevalence of risk factors by age group is shown in Supplementary Fig. 1.

When considering cases of hypertension, the proportions of aware and treated participants increased significantly between 1986 and 2013 in both sexes (Table 2). The proportion of controlled participants also rose significantly over time in men (P for trend < 0.001) and in women (P for trend < 0.001) (Table 2). For dyslipidaemia, the proportion of disease-aware participants increased between 1986 and 2013 in both sexes, with the greatest increase occurring between 1986–1988 and 2005–2007. In men, the proportion of treated participants increased significantly; again, the greatest increase occurred between 1986–1988 and 2005–2007. In women, the proportion of treated participants did not change significantly between 1986 and 2013, although it did decrease between 2005–2007 and 2011–2013, after a peak in 2005–2007. The proportion of diabetes-aware participants increased significantly between 1995 and 2013 in women (from 53.2% to 82.6%; P for trends < 0.05) (Table 2), and remained stable in men.

Secondary prevention

Changes over time in the prevalence of cardiovascular risk factors in patients in the French EUROASPIRE survey (interviewed at least 6 months after hospitalisation for coronary heart disease) are presented in Table 3. The patients’ mean age increased significantly between 1992 and 2013. Moreover, the prevalence of self-reported diabetes, antihypertensive medication use and antihyperlipidemic medication use all increased significantly. The prevalence of dyslipidaemia decreased significantly, whereas the prevalence of obesity, smoking and high blood pressure did not change markedly.

Trends in risk scores and mortality

In men, the age-standardized CHD mortality rate fell from 119 per 10,000 in 1986–1988 to 56 per 100,000 in 2011–2013 — corresponding to a mean (95% CI) decrease of 2.60%
(2.18–3.03%) per year in the mortality rate. Concomitantly, an analysis of the SCORE CHD risk score (Fig. 2) revealed a significant decrease in the mean 10-year predicted risk of fatal CHD. Between 1986–1988 and 2011–2013, the risk fell from 2.8% to 1.5%; this corresponds to a decrease of 2.02% (1.78–2.25%) per year in the estimated risk. Between 1996 and 2013, the mean decrease in the mortality rate was 2.34% (1.21–3.46%) per year. The mean decrease in the CHD score was 1.38% (1.00–1.75%), and the mean decrease in the Framingham-Wilson score was 1.08% (0.74–1.41).

In women, the age-standardized CHD mortality fell from 32 per 10,000 in 1986–1988 to 18 per 100,000 in 2011–2013—corresponding to a mean (95% CI) decrease of 2.79% (1.91–3.65%) per year in the mortality rate. Concomitantly, the SCORE CHD risk score (Fig. 2) fell from 0.67% to 0.40%; this corresponds to a decrease of 1.55% (1.32–1.78%) per year in the estimated risk. Between 1996 and 2013, the mean decrease in the mortality rate was 3.50% (1.18–5.76%) per year. The mean decrease in the CHD score was 1.29% (0.95–1.63%), and the mean decrease in the Framingham-Wilson score was 0.93% (0.61–1.12%).

**Sensitivity analysis**

The corrected prevalences (weighted by occupational group, as obtained from INSEE census data) were similar to the non-corrected prevalences (Supplementary Table S2).
**Discussion**

In inhabitants of the Lille urban area (northern France) aged 40–64 years, the prevalence of most main cardiovascular risk factors fell between 1986 and 2013. The prevalence of diabetes mellitus in men and the prevalence of smoking and being overweight in women were stable. In contrast, the prevalence of being overweight increased in men. Overall, the 10-year predicted risk of fatal CHD fell over time. Furthermore, our study highlighted the improvement in cardiovascular risk factor management in primary and secondary prevention.

The prevalence of the cardiovascular risk factors included in the SCORE equation (hypertension, smoking and dyslipidaemia) decreased in a consistent manner. Similar trends for smoking have generally been observed elsewhere in Europe. The observed decrease in the prevalence of hypertension is consistent with trends observed in high-income Western countries – despite an increase in BMI [15]. Conversely, mean blood pressure did not change markedly.
### Table 2  Standardized proportions of aware, treated and controlled cases among participants with hypertension, diabetes mellitus or dyslipidaemia.

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hypertension (%)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awareness</td>
<td>41.4</td>
<td>45.2</td>
</tr>
<tr>
<td>Treatment</td>
<td>50.5</td>
<td>79.5</td>
</tr>
<tr>
<td>Control</td>
<td>9.3</td>
<td>16</td>
</tr>
<tr>
<td><strong>Dyslipidaemia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awareness</td>
<td>29.1</td>
<td>40.9</td>
</tr>
<tr>
<td>Treatment</td>
<td>40.5</td>
<td>56.4</td>
</tr>
<tr>
<td>Control&lt;sup&gt;b&lt;/sup&gt;</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td><strong>Diabetes mellitus</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awareness&lt;sup&gt;c&lt;/sup&gt;</td>
<td>–</td>
<td>56.5</td>
</tr>
<tr>
<td>Treatment&lt;sup&gt;c&lt;/sup&gt;</td>
<td>–</td>
<td>96.8</td>
</tr>
<tr>
<td>Control&lt;sup&gt;d&lt;/sup&gt;</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

Data are expressed as a percentage of the previous line.

<sup>a</sup> Logistic regression analysis (with the study date as a quantitative variable) adjusted for age class.

<sup>b</sup> Therapeutic threshold not available for three of the four studies.

<sup>c</sup> Glycaemia not available for MONICA<sub>1986–1988</sub>.

<sup>d</sup> Glycated haemoglobin (HbA1c) measurement not available for MONICA<sub>1986–1988</sub> and MONICA<sub>1995–1996</sub>.

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Table 3  Prevalence of risk factors at least 6 months after hospitalization for a coronary heart event or procedure in the French EUROASPIRE study centre.

<table>
<thead>
<tr>
<th></th>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of patients</td>
<td>396 (74.0—82.1)</td>
<td>365</td>
<td>341</td>
<td>377</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>78.0 (74.0—82.1)</td>
<td>81.1 (77.1—85.1)</td>
<td>79.2 (74.9—83.5)</td>
<td>78.8 (74.7—82.9)</td>
<td>0.94</td>
</tr>
<tr>
<td>Age at interview ≥ 60 years</td>
<td>33.3 (28.7—38.0)</td>
<td>42.5 (37.4—47.5)</td>
<td>57.5 (52.2—62.7)</td>
<td>51.5 (46.4—56.5)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Current smoker at interview</td>
<td>25.0 (20.7—29.3)</td>
<td>24.2 (19.8—28.6)</td>
<td>24.8 (19.7—30.0)</td>
<td>25.2 (20.8—29.6)</td>
<td>0.91</td>
</tr>
<tr>
<td>Obesity (BMI &gt; 30 kg/m²)</td>
<td>33.4 (28.7—38.1)</td>
<td>37.5 (32.5—42.5)</td>
<td>36.8 (30.9—42.7)</td>
<td>36.0 (31.1—40.9)</td>
<td>0.5</td>
</tr>
<tr>
<td>Self-reported diabetes</td>
<td>16.7 (13.0—20.3)</td>
<td>27.5 (22.9—32.1)</td>
<td>34.2 (28.5—39.9)</td>
<td>32.1 (27.4—36.8)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Undetected diabetes&lt;sup&gt;c&lt;/sup&gt;</td>
<td>—</td>
<td>15.2 (10.9—19.5)</td>
<td>8.9 (4.6—13.2)</td>
<td>10.1 (6.2—14.1)</td>
<td>0.07</td>
</tr>
<tr>
<td>Controlled diabetes&lt;sup&gt;d&lt;/sup&gt;</td>
<td>—</td>
<td>9.2 (3.5—14.9)</td>
<td>7.8 (2.2—13.3)</td>
<td>16.7 (9.4—23.9)</td>
<td>0.10</td>
</tr>
<tr>
<td>Raised blood pressure&lt;sup&gt;e&lt;/sup&gt;</td>
<td>51.4 (46.5—56.3)</td>
<td>60.7 (55.7—65.7)</td>
<td>56.3 (50.4—62.2)</td>
<td>46.9 (41.9—52.0)</td>
<td>0.14</td>
</tr>
<tr>
<td>Antihypertensive agents</td>
<td>88.9 (85.8—92.0)</td>
<td>90.7 (87.7—93.6)</td>
<td>98.1 (96.5—99.8)</td>
<td>96.8 (95.0—98.6)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>LDL ≥ 3 mmol/L</td>
<td>—</td>
<td>60.1 (54.8—65.3)</td>
<td>22.3 (17.1—27.5)</td>
<td>13.8 (10.2—17.5)</td>
<td>&lt;0.0001</td>
</tr>
<tr>
<td>Lipid-lowering drugs</td>
<td>41.7 (36.8—46.5)</td>
<td>68.1 (63.3—72.9)</td>
<td>91.7 (88.4—95.0)</td>
<td>96.6 (94.7—98.4)</td>
<td>&lt;0.0001</td>
</tr>
</tbody>
</table>

Data are expressed as the crude percentage (95% confidence interval). BMI: body mass index; LDL: low-density lipoprotein.

<sup>a</sup> Given that non-fasting samples were collected, glycaemia and LDL are missing for the period 1992—1994.

<sup>b</sup> x² for trend.

<sup>c</sup> Fasting glucose ≥ 7 mmol/L in participants without known diabetes.

<sup>d</sup> Fasting glucose < 6 mmol/L in participants with known diabetes.

<sup>e</sup> Systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg for participants without diabetes, and systolic blood pressure ≥ 130 mmHg and/or diastolic blood pressure ≥ 80 mmHg for participants with diabetes.


in men in Eastern Europe, and increased in lower-income countries [16]. The fall in blood pressure seems to be the result of birth cohort and period effects [1]. The reasons for this decrease have not been identified. Reduced salt intake and increased consumption of fruits, vegetables and potassium might be involved [1]. We highlighted a decrease in the prevalence of dyslipidaemia. Cholesterol levels have decreased in high-income countries, which might be the result (at least in part) of better dyslipidaemia care. However, the trends observed in western countries are inconsistent [17—19]. When defined as a value above the therapeutic threshold or the administration of treatment, the prevalence does not depend on screening or care; hence, a decrease in the prevalence of these risk factors evidences the contribution of behavioural and environmental factors.

In addition to this decrease in prevalence, our study also highlighted improvements in care of cardiovascular risk factors. Indeed, the proportions of aware and treated participants increased for all risk factors (except for dyslipidaemia in women). The implementation of guidelines with treatment goals (based on the number of cardiovascular risk factors, and with different age limits for men and women) might explain the observed decrease (in women only) in the proportion of treated dyslipidaemia between MONICA1986—1988 and MONALISA2005—2007 and ELISABET2011—2013. The lower proportions of aware participants and controlled participants in MONICA1986—1988 might be explained (at least in part) by differences in therapeutic thresholds; before 1997, hypertension was defined as SBP > 160 mmHg or DBP > 95 mmHg.

The prevalence of being overweight increased in men and remained stable in women. The increase in men is in agreement with previous findings in France [13,20]. Similar increases in the prevalence of obesity have been observed at a European level and worldwide [15].

We observed a significant reduction in the prevalence of diabetes mellitus in women. The prevalence in men was stable. An increased prevalence of diabetes has been observed worldwide, with particularly rapid increases in Melanesia, Polynesia, the Middle East and North Africa. However, this trend is less homogeneous in Europe. For women, only a small increase was observed in central and eastern Europe, and almost no change was observed in northwestern and southwestern Europe. For men, only a small rise was observed in northwestern Europe [21]. Our data are

Temporal trends in prevalence and treatment of cardiovascular risk factors

Therefore consistent with the stable prevalence of diabetes observed in northwestern Europe. Moreover, the low proportion of aware patients found in MONICA1995–96 might be partly because of a change in the recommended diagnostic threshold (from 1.40 g/L for MONICA1995–96 to 1.26 g/L for MONALISA2005–2007), as (for comparative purposes) we applied the latter definition to all studies.

The mortality rate fell dramatically between 1985 and 2011 (2.6% per year for men and 2.8% per year for women). The CHD risk estimated using the SCORE equation fell only slightly more slowly than the mortality rate, particularly for men (2.0% in men and 1.6% in women). This observation suggests that primary prevention contributed strongly to the decrease in mortality rate. The decrease in the risk score can be explained by a decrease in the prevalence of the cardiovascular risk factor included in the SCORE equation, and better of treatment of these cardiovascular factors. Our results suggested that improvements in environmental and behavioural factors on one hand and better management of cardiovascular risk factors on the other contributed to better primary prevention of CHD. In contrast to the factors included in the SCORE equation, the prevalence of being overweight increased or remained stable, and the prevalence of diabetes remained stable in men. The SCORE equation may therefore have overestimated the decrease in coronary risk. Indeed, when analysing the Framingham-Wilson score (which included obesity and diabetes) over the period 1996–2013, the decrease in the risk was slightly lower than that calculated with the SCORE equation. However, the time trends were similar.

The treatment of acute coronary syndrome and secondary prevention also contribute to the reduction in CHD mortality. Analyses of the French Registry of Acute ST-Elevation and Non-ST-elevation Myocardial Infarction found that mortality after hospitalisation for acute coronary syndrome decreased dramatically between 1995 and 2010. The 30-day mortality rate in patients with ST-segment elevation myocardial infarction decreased from 11.3% to 4.4% [22]. Concomitantly, the 1-year mortality rate halved in patients with non-ST-segment elevation myocardial infarction [23] and in elderly patients admitted with myocardial infarction [24]. The EUROASPIRE survey enabled us to assess changes in the prevalence of coronary risk factors (notably with regard to secondary prevention) over a 20-year period in subjects recently hospitalised for a coronary event or procedure. These data revealed a clear reduction in antihypertensive medication use and cholesterol concentration between 1992 and 2013. Furthermore, antihypertensive medication use (although already high) is still increasing slightly.

Study strengths and limitations

This study had several strengths. In particular, we used data collected over a 25-year period in surveys that used similar methodologies for measuring cardiovascular risk factors, and measured coronary mortality with a stable definition in the same population and the same period.

However, the response rate was lower in ELISABET2011–2013 than in the three other surveys. This might have been the result of the survey protocol (which involved longer examinations) and greater difficulty in obtaining participants’ numbers from the telephone directory. Nevertheless, our analysis of occupational group distribution does not suggest the presence of greater sampling bias in the ELISABET2011–2013 study. In both the MONALISA2005–2007 and ELISABET2011–2013 surveys, mid-level professions were over-represented, and blue-collar workers were under-represented. A sensitivity analysis suggested that sampling bias did not have a major impact in these two surveys. A lack of data prevented us from analysing the occupational group distribution in the MONICA1986–1998 and MONICA1995–1996 studies; however, the participation rate was high (and similar to that found in the MONALISA2005–2007) in both studies. Furthermore, we observed continuous trends suggesting a moderate impact of selection bias. Moreover, the lower participation rate among younger people explains why the subjects of ELISABET studies are slightly older. However, this difference is corrected by standardization and adjustment.

With regard to the measurement of cardiovascular risk factors, the four surveys analysed here were not designed to differentiate between type II diabetes and other types of diabetes. However, other types of diabetes account for <10% of treated cases in France [25]. The diagnosis of diabetes on the basis of a single fasting blood glucose measurement is not strictly in line with current guidelines. Furthermore, there were slight inter-survey differences in blood pressure measurement protocol. Lastly, only one measure was available for most of the subjects in the ELISABET2011–2013 survey. However, we estimate that the potential reclassification rate was <9% (data not shown).

Lastly, changes in the diagnosis and management of coronary events prevented the use of very similar inclusion criteria in the four EUROASPIRE studies. The diagnosis criteria changed, and the upper limit on age at inclusion changed from 70 years in the first two studies to 80 years in the third and fourth studies. However, these sources of bias are unlikely to account entirely for the strong trends observed here—especially the change in lipid-lowering drug use.

The estimation of trends in the coronary heart event rate should help us to understand the contribution of primary prevention. However, changes in definitions and diagnoses complicate the interpretation of incidence rates over a long period. Trends in incidence were previously estimated in the Lille MONICA registry. Between 1985 and 1994, the incidence of coronary events fell by an average of 1.1% per year in men and 1.6% in women [2]. Between 2000 and 2007, the average incidence of definite myocardial infarction decreased in men from 317 to 270 per 100,000, and decreased in women from 80 to 69 per 100,000 using two different definitions for each periods [26], showing the contribution of decreased incidence to the reduction of mortality.

Conclusions

The present data allowed us to simultaneously study the long-term trends in cardiovascular risk factors and cardiovascular mortality in a large population. Our observations enabled us to more accurately estimate the contribution of primary prevention to the decrease in mortality; indeed, primary prevention accounted for a large proportion of the decrease in mortality. On one hand, the decreased prevalence of most cardiovascular risk factors attests to the contribution of behavioural and environmental changes. On
the other, the higher proportion of treated cases and better levels of control attest to the contribution of better care.

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Disclosure of interest
The authors declare that they have no competing interest.

Appendix A. Supplementary data
Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.acvd.2017.03.009.

References
[9] Institut national de la statistique et des études économiques. Available at: https://www.insee.fr/fr/accueil.


