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ORIGINAL ARTICLE

Temporal trends of cardiovascular health factors among 366 270 French adults

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Aims We aimed to investigate time trends in cardiovascular health (CVH) metrics in the population at large, as well as in important subgroups.

Methods and results In this study, we used a community-based sample of 366 270 adults from France who had a standardized examination to assess cardiovascular risk factors between 1992 and 2011 (20 years). Cardiovascular health metrics categorized into ideal, intermediate, and poor categories were computed using smoking, physical activity, body mass index, total cholesterol, blood glucose, and blood pressure. Matching on age, sex, and depression across 5-year periods (1992–96, 1997–2001, 2002–06, and 2007–11) was performed in order to correct for the sociodemographic differences between the examinations at different periods of times. Mean age across all four time periods was 44.7 (SD 13) years and 38% (138 228) were women. Overall, few participants (≤3.5%) met all six ideal CVH metrics at any time point. The prevalence of meeting ≥5 ideal CVH metrics increased from 6.7% in 1992–96 to 15.0% in 2007–11 ($P < 0.001$). A significant improvement in CVH (meeting ≥5 ideal CVH metrics) from 1992 to 2011 was observed among younger (from 7.5% to 16.6%) and older individuals (from 1.3% to 4.2%), men (from 4.4% to 11.8%) and women (from 10.4% to 20.1%), those with low (from 9.1% to 10.4%) and high education status (from 15% to 18.1%) and those with (from 5.1% to 12.7%) and without depressive symptoms (from 6.8% to 15.1%). However, the rate of improvement was steepest in the most affluent group in comparison with those with lower socio-economic status.

Conclusion Overall CVH improved from 1992 until 2006 and slightly decreased between 2006 and 2011 in French adults. From 1992 until 2006, the improvement in CVH was less pronounced among those with low socio-economic status as compared to those with a higher socio-economic status.

Keywords Prevention • Risk factors • Socio-economic status • Population Attributable Risk for Mortality

Introduction

Primordial prevention is the concept of preventing the development of cardiovascular disease (CVD) risk factors (i.e. hypertension and diabetes) and events (i.e. stroke and myocardial infarction) through the maintenance of healthy lifestyle. It has been increasingly emphasized as a pre-emptive and complimentary strategy to pharmacological treatment of chronic CVD in order to lower CVD risk in the population.[1] To improve rates of primordial prevention, the American Heart Association (AHA) has targeted four behavioural

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[smoking, body mass index (BMI), physical activity, and diet] and three biological factors (total cholesterol, fasting glucose, and blood pressure) associated with cardiovascular health (CVH).[1] Prior research has demonstrated that individuals with a higher number of ideal CVH metrics have a substantially reduced risk of cardiovascular-related and all-cause mortality.[2] Benefits of ideal CVH have been shown in young adults,[3–5] older adults,[6–9] and elderly populations.[10]

Data on current time trends of CVH levels in the population are limited. Four studies conducted in the USA using data from the National Health and Nutrition Examination Survey (NHANES),[7,11] the Framingham Heart Study,[12] and the Atherosclerosis Risk in Communities (ARIC) study[13] reported that the percentage of adults meeting all ideal CVH metrics is low, has remained low,[11] or even declined in recent decades.[7,12,13] Trends of no improvement in CVH over time have also been observed in Canada[14] and Korea.[15] In contrast, a recent study from Denmark[16] reported increase in the prevalence of ideal CVH from 1978 to 2006. However, this study relied primarily on self-reported measures of CVH. Furthermore, current time trends of objectively measured CVH over time in France are unknown. Therefore, to investigate time trends in CVH metrics, we analysed data from a community-based sample of 366 270 adults who underwent a standardized examination of cardiovascular risk factors at a preventive medical centre in Paris, France between 1992 and 2011. Additionally, published data on time trends of CVH in important subgroups is also lacking. Whereas it has been shown that CVH is poorer in older individuals,[7] men,[17] people with a lower socio-economic status,[17] suffering from depressive symptoms,[18] little is known on how these characteristics relate to changes in CVH over time. Therefore, a secondary purpose of this article is to investigate time trends among population subgroups which may provide useful information about achievable levels of risk reduction.

Methods

Study population

Individuals were examined at the Centre d'Investigations Préventives et Cliniques (IPC Centre), a preventive medical centre in Paris, France. In France, free standardized medical examinations subsidized by the National Insurance System for Salaried Workers are offered to all working and retired adult employees and their families. The IPC Centre is one of the largest preventive medical centres in France and conducts 20 000–25 000 examinations/year. The catchment area of the IPC Centre is the city of Paris and its surrounding suburbs, an area covering 11 million inhabitants. The present study included individuals who had an examination at the IPC Centre between January 1992 and December 2011. Of the 369 277 individuals who had an examination, we excluded individuals with prior CVD ($n = 3007$, 0.8%). The total study population thus consisted of 366 270 individuals. All subjects provided written informed consent for their data to be used for epidemiological studies, and the IPC Centre received authorization for epidemiological data analyses from the French commission on data protection (Commission Nationale de l'Informatique et des Libertés). More in-depth information on data collection has been previously described.[19]

Measurement and definitions of cardiovascular health

We utilized modified AHA definitions of ideal, intermediate and poor CVH for adults to fit our data.[1] The modified definitions used in our analyses are presented in *Table 1*. In the present study, data were available on all CVH metrics, except the diet metric.

Body mass index was calculated from weight and height measurements obtained using calibrated scales and a wall-mounted stadiometer, respectively. Ideal body weight was defined as a BMI <25 kg/m^2. Smoking was assessed by a standardized questionnaire, and ideal smoking was defined as not smoking (never smoked or quit smoking >12 months). Physical activity was measured by a standardized questionnaire about time spent walking per day. Ideal physical activity was defined as walking ≥1 h/day. Blood pressure was measured from January 1992 until July 1998 using a manual mercury sphygmomanometer and from July 1998 until December 2011 with a validated digital blood pressure device (TM-2541, A&D Company, Tokyo, Japan). At each examination, blood pressure was measured three times on the right arm in the supine position after a 10-min rest. The mean of the last two measurements was used in the analyses. Ideal blood pressure was defined as untreated blood pressure of <120/80 mmHg. Lipid profile and glucose were measured following an overnight fast. Ideal total cholesterol was defined as untreated values of <200 mg/dL (to convert cholesterol to mmol/L, multiply values by 0.0259); and ideal fasting plasma glucose as untreated values of <100 mg/dL (to convert glucose to mmol/L, multiply by 0.0555).

For time trend analyses, we constructed an ideal CVH metric score by dichotomizing each of the six CVH metrics assigning 1 point for the AHA ideal category and 0 points for the other categories. CVH points were summed for each participant and they were then classified as having 0, 1, 2, 3, 4, 5, or 6 ideal CVH metrics. For this score, we excluded participants with missing data on ≥1 of the CVH metrics.

Covariates

Self-administered questionnaires were used to assess socio-economic status, depressive symptoms, medical history, and medication use. Socio-economic status was estimated by two measures: education level [available since 1997 only; divided into low (no or primary education), intermediate (secondary education), and high (higher education or university)] and the EPICES deprivation score (available since 2002). The EPICES deprivation score is a summary measure of socio-economic deprivation and has been validated in France in a sample of 200 000 persons against two other indices of deprivation, i.e. the Townsend and the Carstairs indexes.[20]

The EPICES deprivation score includes 11 items on marital status, health insurance coverage, socio-economic status, family support, and leisure and recreational activities (the full questionnaire is provided in Supplementary material online). A positive response to an item was attributed to a weight corresponding to the regression coefficient, whereas a negative response was attributed to a weight of 0. The score was obtained by adding each weight to the intercept and varied from 0 to 100, with higher scores indicating lower socio-economic status, as described previously.[20] Depressive symptoms were assessed using the 13-item Questionnaire of Depression 2nd version, Abridged (QD2A).[21] Participants with a score ≥7 on the 13-item Questionnaire of Depression 2nd version, Abridged or who were on antidepressants were referred as having high level of depressive symptoms.

Statistical analyses

We calculated patient characteristics and prevalence of CVH metrics for four pre-specified examination periods spanning 5 years: 1992–96, 1997–2001, 2002–06, and 2007–11. Each examination period was comprised mostly of different participants. We used logistic regression analyses to test for changes in CVH metrics across the examination periods adjusted for age and sex. Tests for linear trend were also performed. Computerized matching was performed. A subject was matched with a

Table 1 Definitions of ideal, intermediate, and poor cardiovascular health for adults

Cardiovascular health metric	AHA definition	Definition in IPC study
Smoking status		
Ideal	Never or quit >12 months ago	Never or quit >12 months ago
Intermediate	Former or quit ≤12 months	Former or quit ≤12 months
Poor	Current smoking	Current smoking
Body mass index		
Ideal	<25 kg/m^2	<25 kg/m^2
Intermediate	25–29.9 kg/m^2	25–29.9 kg/m^2
Poor	≥30.0 kg/m^2	≥30.0 kg/m^2
Physical activity		
Ideal	≥150 min/week moderate or ≥75 min/week vigorous or ≥150 min/week moderate + vigorous	In the IPC study from 1992 one question was asked about whether or not individuals walked for ≥60 min/day. Ideal physical activity was defined as ≥60 min walking/day.
Intermediate	1–149 min/week moderate or 1–74 min/week vigorous or 1–149 min/week moderate + vigorous	Not available
Poor	None	None
Healthy diet score		
Ideal	4–5 components	Not available
Intermediate	2–3 components	Not available
Poor	0–1 components	Not available
Blood pressure		
Ideal	SBP <120 and DBP <80 mmHg	SBP <120 and DBP <80 mmHg
Intermediate	SBP 120–139 or DBP 80–89 mmHg or treated to goal	SBP 120–139 or DBP 80–89 mmHg or treated to goal
Poor	SBP ≥140 or DBP ≥90 mmHg	SBP ≥140 or DBP ≥90 mmHg
Total cholesterol		
Ideal	<200 mg/dL	<200 mg/dL
Intermediate	200–239 mg/dL or treated to goal	200–239 mg/dL or treated to goal
Poor	≥240 mg/dL	≥240 mg/dL
Fasting plasma glucose		
Ideal	<100 mg/dL	<100 mg/dL
Intermediate	100–125 mg/dL or treated to goal	100–125 mg/dL or treated to goal
Poor	≥126 mg/dL	≥126 mg/dL

AHA, American Heart Association; IPC, Centre d'Investigations Préventives et Cliniques; DBP, diastolic blood pressure; SBP, systolic blood pressure.

subject of each period (i.e. 3 subjects). The matching was made for age (±2 years), sex, and depressive status using the SAS macro gmatch was used (SAS software, version 9.4).

All analyses were conducted using the total study population and after stratification for the following subgroups: age (<60 years vs. ≥60 years), sex, education level (low, intermediate, and high education), and EPICES deprivation score (tertiles). *P* values for interaction between subgroups were tested.

Sensitivity analysis

We conducted several sensitivity analyses. First, we calculated the prevalence for the blood pressure metric as determined 2 years before and after the new blood pressure measurement device was introduced. The rationale behind this analysis is to evaluate any potential effect of changes that occurred in how blood pressure was measured during the study period. Second, from 1997 onwards additional information on practicing sports was available. We, therefore, repeated the analyses for trends in physical activity from 1997 onwards with ideal physical activity levels defined as walking ≥1 h/day and practicing sports ≥3 times/week. Third, we repeated the analyses with an ideal CVH metric score that did not include the physical activity metric. Fourth, we re-calculated the prevalence of the CVH metrics per year instead of per examination period of 5 years.

We used SAS software, version 9.4. Two-tailed *P* values of <0.05 were considered statistically significant.

Results

Temporal trends in the total study population

Our study included 366 270 individuals with a mean age across all four time periods (i.e. 1992–96, 1997–2001, 2002–06, 2007–11) of 44.7 (SD 13) years of which 38% (138 228) were women (*Table 2*). The prevalence of CVH by examination period (i.e. 1992–96, 1997–2001, 2002–06 and 2007–11) for the population ($N = 273\ 272$, i.e. $N = 68\ 318$ by period) after the matching is reported in *Table 3*. The

Table 2 Characteristics of the study population by 5-year examination period

Characteristics	Examination period			
	1992–96	1997–2001	2002–06	2007–11
Number of participants	121 085	85 477	83 661	76 047
Age (years)	45.6 ± 12.9	45.7 ± 12.7	43.7 ± 12.9	43.3 ± 13.6
Sex				
Women	36.6 (44 342)	36.2 (30 941)	36.8 (30 756)	42.3 (32 189)
Men	63.4 (76 743)	63.8 (54 536)	63.2 (52 905)	57.7 (43 858)
Education				
Low	NA	12.3 (1976)	15.6 (12 940)	19.7 (14 804)
Intermediate	NA	44.4 (7110)	41.1 (33 993)	39.7 (29 871)
Higher	NA	43.3 (6935)	43.3 (35 862)	40.6 (30 539)
EPICES deprivation score	NA	NA	20.1 (8.3–39.6)	24.9 (13.6–46.8)
Depressive symptoms				
Yes	7.7 (8814)	7.4 (5915)	8.2 (6856)	8.0 (5972)
No	92.3 (105 658)	92.6 (73 543)	91.8 (76 787)	92.1 (69 190)

Data are displayed as mean ± standard deviation, median (interquartile range), or % (*n*).
NA, not available.

prevalence of meeting ≥5 ideal CVH metrics increased from 6.7% in 1992–96 to 16.5% in 2002–06 then slightly decreased between 2002–06 and 2007–11 ($P < 0.001$). The prevalence of meeting ≤1 ideal CVH metrics decreased from 22.7% to 13.2% ($P < 0.001$) over this time period. For individual metrics, the prevalence of ideal smoking increased from 1992–96 to 2007–11. Also, the prevalence of individuals with desirable levels of total cholesterol (<200 mg/dL) and blood pressure (<120/80 mmHg) increased from 1992–96 to 2007–11 ($P < 0.001$). In contrast, the prevalence of having a BMI ≤25 kg/m^2 declined from 1992–96 to 2007–11 ($P < 0.001$). In addition, the prevalence of ideal levels of physical activity (walking ≥1 h/day and/or practicing sports ≥3 times/week) increased from 1992–96 to 1997–2001 but declined thereafter. Similarly, desirable levels of fasting glucose (<100 mg/dL) increased from 1992–96 to 2002–06 but declined thereafter. The temporal trends in ideal CVH per year were qualitatively similar as the prevalence calculated per examination period of 5 years (*Figure 1*).

Temporal trends by subgroups

The prevalence of CVH metrics according to age, sex, education, EPICES deprivation score, and depressive symptoms are provided in *Table 4*. Younger participants, women, those with higher education, those with lower EPICES deprivation score, and those without depressive symptoms tended to meet a greater number of CVH metrics at any time point. Overall CVH improved in all subgroups, but the improvement in overall CVH was stronger in men, higher education (*P*-interactions < 0.001). In addition, individuals in the highest tertile of the EPICES deprivation score (indicating lower socio-economic status) had a greater decline in CVH than those in the lower tertiles from 2002–06 to 2007–11 (*P*-interaction < 0.001; data on the EPICES deprivation score were available beginning from 2002). There were no differences in trends in meeting ≥5 ideal CVH according to age or presence of depressive symptoms (*P*-interactions 0.74 and 0.65, respectively). The trends by subgroup of the individual CVH metrics are provided in the Supplementary material online, *Tables S1–S5*. The temporal trends in ideal CVH by subgroups per year were qualitatively similar as the prevalence calculated per examination period of 5 years (*Figure 2*). The same trend for poor and intermediate CVH are shown in Supplementary material online, *Figures S2* and *S3*, respectively.

Additional analyses

The prevalence of blood pressure determined 2 years before and after the new blood pressure device was introduced were qualitatively similar (Supplementary material online, *Table S6*). In addition, the prevalence of ideal physical activity was qualitatively similar when we defined ideal physical activity as walking ≥1 h/day and practicing sports ≥3 times/week (Supplementary material online, *Table S7*). When we re-calculated the overall CVH metric score without physical activity, results did not materially change (Supplementary material online, *Table S8*). Finally, the prevalence of the CVH metrics per year was qualitatively similar as the prevalence calculated per examination period of 5 years (Supplementary material online, *Figure S1*).

Discussion

The present study found that overall CVH improved in French adults from the community who benefited from a free standardized health examination in the Paris area (from 1992 until 2011). An improvement was present in all subgroups, i.e. younger and older individuals, men, and women, those with low and high socio-economic status and those with and without depressive symptoms. However, the rate of improvement was steepest in men and in the most affluent group in comparison with those with lower socio-economic status. Furthermore, while CVH improved from 1992 to 2011, the prevalence of ≥5 ideal CVH metrics was slightly lower in 2007–11 in contrast to 2002–06; however, we did not explicitly test for this.

Table 3 Temporal trends in prevalence of cardiovascular health in the total study population

Cardiovascular health metrics	Examination period				*P*-value[a,b]	*P* for trend
	1992–96 (*N* = 68 18)	1997–2001 (*N* = 68 318)	2002–06 (*N* = 68 318)	2007–11 (*N* = 68 318)		
Number of ideal cardiovascular health metrics						
0	4.1% (2819)	2.4% (1657)	1.7% (1190)	1.9% (1320)	Ref	<0.001
1	18.6% (12 708)	11.9% (8147)	9.8% (6718)	11.2% (7673)	<0.001	<0.001
2	27.8% (19 013)	23.2% (15 825)	21.3% (14 552)	22.5% (15 367)	<0.001	<0.001
3	26.2% (17 874)	27.1% (18 485)	26.9% (18 402)	26.6% (18 142)	<0.001	<0.001
4	16.6% (11 348)	21.9% (14 944)	23.7% (16 168)	22.8% (15 596)	<0.001	<0.001
5	5.9% (3999)	11.1% (7606)	13.2% (9031)	12.0% (8213)	<0.001	<0.001
6	0.8% (557)	2.4% (1654)	3.3% (2257)	2.9% (2007)	<0.001	<0.001
0–1	22.7% (15 527)	14.4% (9804)	11.6% (7908)	13.2% (8993)	<0.001	<0.001
≥5	6.7% (4556)	13.6% (9260)	16.5% (11 288)	15.0% (10 220)	<0.001	<0.001
Individual cardiovascular health metrics[c]						
Smoking						
Poor: current	28.3% (19 202)	31.7% (21 642)	30.2% (20 647)	28.0% (19 133)	Ref	<0.001
Intermediate: former or quit ≤12 months	3.0% (2025)	3.1% (2103)	2.1% (1414)	1.8% (1208)	<0.001	<0.001
Ideal: never or quit >12 months	68.7% (46 617)	65.2% (44 568)	67.7% (46 257)	70.2% (47 961)	<0.001	<0.001
Body mass index						
Poor: ≥30 kg/m^2	7.2% (4890)	9.4% (6392)	11.6% (7842)	14.1% (9459)	Ref	<0.001
Intermediate: 25–30 kg/m^2	32.0% (21 838)	32.8% (22 397)	33.2% (22 564)	34.0% (22 855)	<0.001	<0.001
Ideal: <25 kg/m^2	60.9% (41 589)	57.8% (39 482)	55.2% (37 474)	51.9% (34 832)	<0.001	<0.001
Physical activity						
Poor: no or walking <1 h/day	62.5% (42 671)	53.0% (36 189)	55.6% (37 979)	56.8% (38 753)	Ref	<0.001
Ideal: walking ≥1 h/day	37.5% (25 632)	47.0% (32 129)	44.4% (30 339)	43.2% (29 528)	<0.001	<0.001
Fasting glucose						
Poor: ≥126 mg/dL	3.8% (2630)	2.3% (1566)	2.4% (1628)	3.2% (2143)	Ref	<0.001
Intermediate: 100–125 mg/dL	52.8% (36 056)	31.8% (21 632)	23.5% (15 984)	29.2% (19 623)	<0.001	<0.001
Ideal: <100 mg/dL	43.4% (29 628)	65.9% (44 927)	74.1% (50 469)	67.6% (45 454)	<0.001	<0.001
Total cholesterol						
Poor: ≥240 mg/dL	32.4% (22 110)	27.7% (18 832)	21.6% (14 728)	18.4% (12 334)	Ref	<0.001
Intermediate: 200–239 mg/dL	36.4% (24 861)	37.0% (25 214)	36.6% (24 936)	36.2% (24 298)	<0.001	<0.001
Ideal: <200 mg/dL	31.2% (21 339)	35.3% (24 055)	41.7% (28 402)	45.4% (30 451)	<0.001	<0.001
Blood pressure						
Poor: ≥140/90 mmHg	27.8% (18 982)	28.4% (19 340)	25.7% (17 227)	22.5% (13 879)	Ref	<0.001
Intermediate: 120–139/80–89 mmHg	60.1% (41 046)	45.3% (30 827)	42.2% (28 244)	45.0% (27 788)	0.32	0.23
Ideal: <120/80 mmHg	12.1% (8280)	26.2% (17 821)	32.1% (21 456)	32.5% (20 098)	<0.001	<0.001

SI conversion factors: To convert total cholesterol values to mmol/L, multiply by 0.0259; to convert glucose values to mmol/L, multiply by 0.0555.
[a]*P*-values for comparisons of estimates between examination period 1992–96 and 2007–11.
[b]*P*-values adjusted for age and sex.
[c]All individuals with available cardiovascular health metrics were included in trend analyses for each specific metric; therefore, sample sizes might vary by the cardiovascular health metrics.

Comparisons between other studies on time trends in CVH are difficult because of differences in the composition of the cohorts, the time period over which data were collected and different definitions used for CVH. Nevertheless, the present study is one of the first to report an overall improvement in CVH in a large community-based population. This improvement was driven by higher ideal levels over time of physical activity, fasting glucose, total cholesterol, and blood pressure, despite higher levels of obesity. In accordance, one study among US employees of a healthcare organization found a small but statistically significant improvement in CVH within a 3-year time period (2011–14) from 0.3% to 0.6%.[22] In addition, a study from Denmark found an improvement in ideal CVH from 1.6% in 1978 to 9% in 2006.[16] In contrast, other studies, from the USA,[7,11,12] Canada,[14] and Korea,[15] found that CVH has remained stable or declined in recent decades. In accordance with previous studies,[7,17] we found that CVH was higher in younger participants and women at any time point, although improvement in CVH was steeper in men compared with women.

The overall improvement of CVH is encouraging and is potentially related to the success of public health effects aimed at increasing the

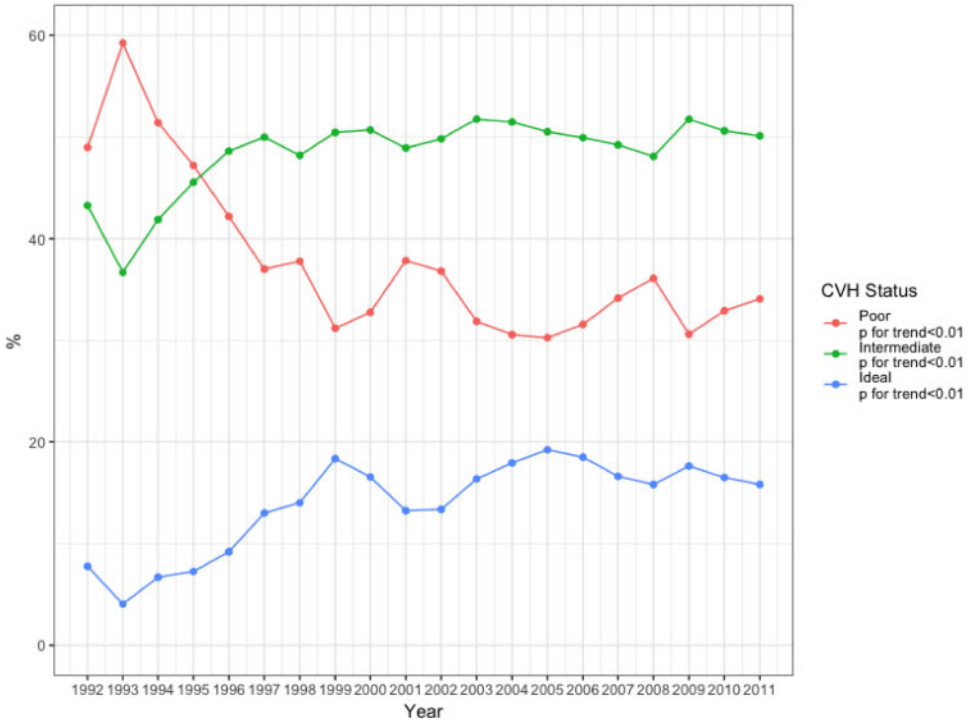

Figure 1 Temporal trends in cardiovascular health status.

Table 4 Temporal trends of meeting ≥5 ideal cardiovascular health metrics by subgroups across the examination periods

Subgroups	Examination period				*P* for interaction[a]
	1992–96 (*N* = 68 318)	1997–2001 (*N* = 68 318)	2002–06 (*N* = 68 318)	2007–11 (*N* = 68 318)	
Age					0.7473
<60 years	7.5% (4439)	14.9% (8850)	18.2% (10 799)	16.6% (9841)	
≥60 years	1.3% (117)	4.5% (410)	5.6% (489)	4.2% (379)	
Sex					<0.0001
Men	4.4% (1850)	10% (4208)	13% (5508)	11.8% (4990)	
Women	10.4% (2706)	19.4% (5052)	22.2% (5780)	20.1% (5230)	
Education					0.0581
Low	NA	9.1% (149)	11.7% (1255)	10.4% (1395)	
Intermediate	NA	12.1% (726)	15.5% (4238)	14% (3640)	
Higher	NA	15% (893)	19.4% (5716)	18.1% (5076)	
EPICES score					<0.0001
Tertile 1	NA	NA	17.4% (3724)	15.7% (3535)	
Tertile 2	NA	NA	19.2% (2682)	17.3% (3175)	
Tertile 3	NA	NA	16.1% (2319)	12.7% (3022)	
Depressive symptoms					0.655
No	6.8% (4291)	13.7% (8635)	16.8% (10 566)	15.1% (9555)	
Yes	5.1% (265)	12% (625)	13.8% (722)	12.7% (665)	

[a]*P*-value for interaction between examination period and subgroup adjusted for age and sex.
NA, not available.

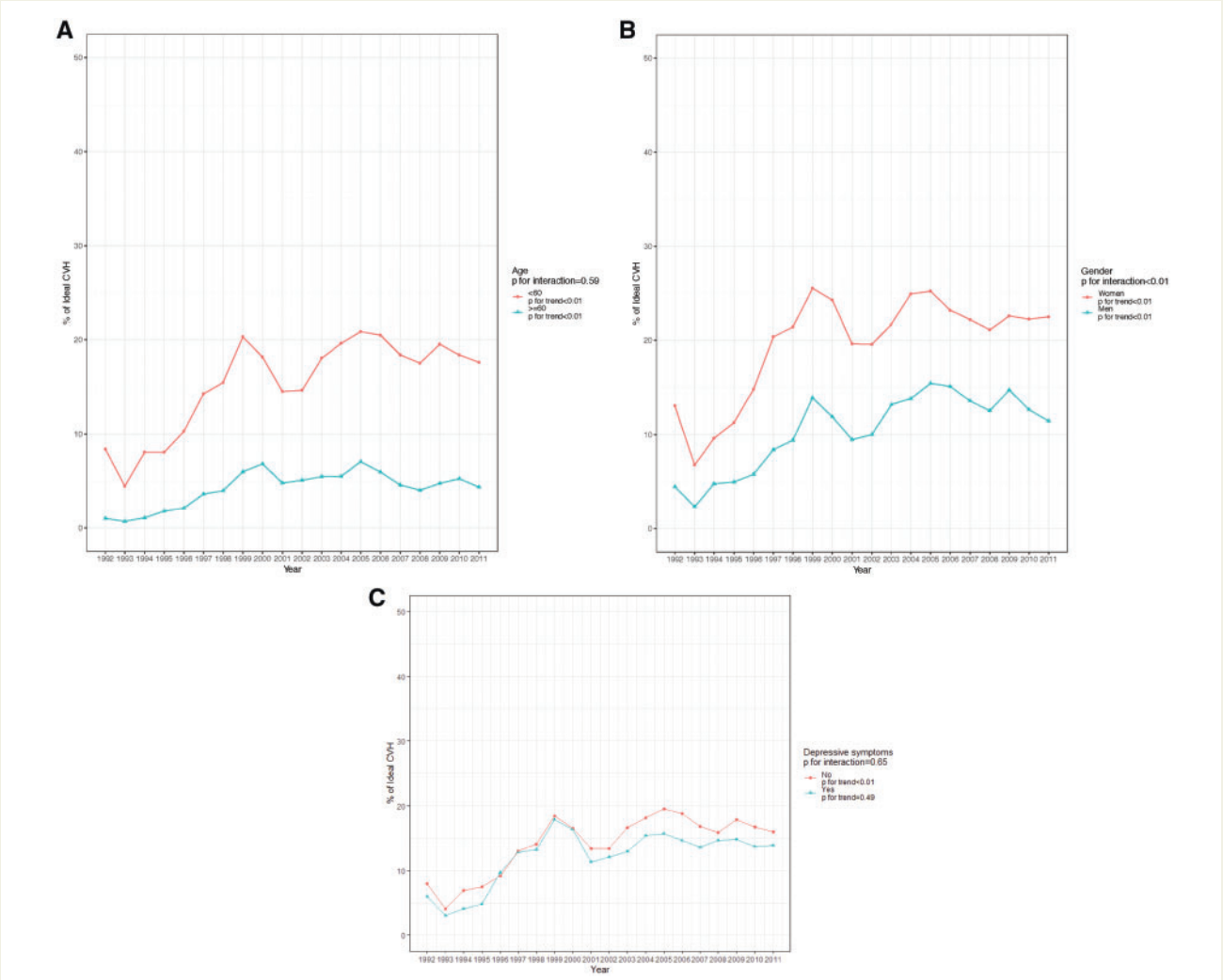

Figure 2 Temporal trends in prevalence of ideal cardiovascular health by subgroups by age (*A*), sex (*B*), depressive symptoms (*C*), education (*D*), and EPICES deprivation score (*E*). Education and EPICES deprivation score were available from 2001 to 2003, respectively.

awareness of CVD risk in our population. This trend mirrors the decreasing cardiovascular mortality in Western Europe.

However, the slight decrease in overall CVH between 2002–06 and 2007–11 emphasizes the continuing importance of focusing efforts on primordial prevention. Physical activity, diabetes, and obesity appeared to be the risk factors which this decreased in overall CVH between 2002–06 and 2007–11.

Although declines in our cohort of the prevalence of smoking (from 1997 to 2006) and hypertension (from 1992 onwards) are encouraging, their prevalence remained higher in our cohort than in most other high-income countries.[23] This reinforces the importance of tobacco control policies and of primordial prevention of hypertension through behavioural and policy changes to continue to improve CVH in our population.

In accordance with other studies,[7,11,12,14–16] we found an increased prevalence of obesity. In addition, the prevalence of desirable levels of physical activity and fasting glucose declined at the end of the study period. These factors have a downstream impact on other cardiovascular risk factors such as fasting glucose and blood pressure. If the trend of increasing prevalence of obesity, physical inactivity, and diabetes continues, this could offset the positive effects of the decline in other cardiovascular risk factors and slow improvements in CVH.

Our study found that CVH improved in individuals of all socio-economic status, but the rate of improvement was steepest in the most affluent groups compared to those with lower socio-economic status. Previous studies noted similar findings in trends between high and low socio-economic groups in overall CVH,[16] individual cardiovascular risk factors (i.e. smoking[24] and diabetes[25]) and coronary heart disease mortality.[26,27] Together these data suggest that efforts to improve CVH are more benefitting those with high socio-economic status than those low socio-economic status, potentially leading to increase the health inequality gap. These improvements among high socio-economic position participants may point to policies that are increasing inequities. This underscores the importance of strategies to improve CVH tailored to those with low socio-economic status.

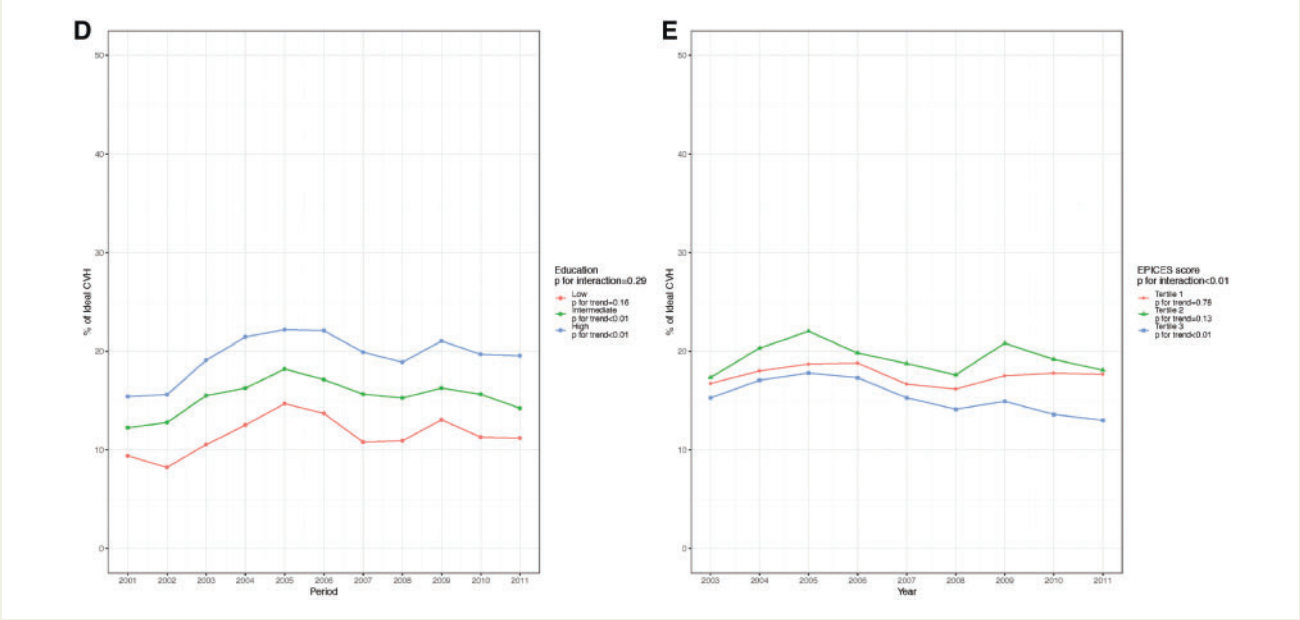

Figure 2 Continued.

Strengths of the present study include its large sample, 20 years of data and available data on important subgroups. However, our study has limitations. First, individuals were recruited in the setting of a primary healthcare centre. Therefore, it is likely they are in better general health than their counterparts of a similar age. Second, no data were available on dietary habits. Third, measurement of physical activity by questionnaire is prone to misclassification due to self-reporting. However, results in overall CVH were qualitatively similar when we repeated the analyses without physical activity. Fourth, changes occurred in how blood pressure was measured during the study period, i.e. blood pressure was measured by a manual sphygmamometer until July 1998 and thereafter by a validated digital blood pressure device. However, it is unlikely that this has influenced our results because the prevalence of the blood pressure metric were qualitatively similar directly before and after the new blood pressure measurement device was introduced.

In conclusion, while CVD overall has improved substantially from 1992 until 2011, there may be a trend in decreasing CVH between 2002–06 and 2007–11 in French adults from the community who participated in free standardized health examination. The improvement in CVH was weaker in women and those with low socio-economic status as compared to those with higher socio-economic status. The alarming decreased in overall CVH between 2002–06 and 2007–11 highlights the ongoing need for primordial prevention to reduce the burden of CVD risk factors.

Supplementary material

Supplementary material is available at *European Heart Journal – Quality of Care and Clinical Outcomes* online.

Conflict of interest: none declared.

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