The association between socioeconomic status and the 90-day risk of cardiovascular events after total hip arthroplasty – registry-based study of 103,286 patients

Nina M EDWARDS [1,2], Eskild B KRISTIANSEN [1], Claus VARNUM [3,4], Søren OVERGAARD [4,5], Rob G H H NELISSEN [6], and Alma B PEDERSEN [1,7]

[1] Department of Clinical Epidemiology, Aarhus University Hospital, Denmark; [2] Department of Orthopaedic Surgery, Regionshospitalet Horsens, Denmark; [3] Department of Orthopaedic Surgery, Lillebaelt Hospital—Vejle, Denmark; Department of Regional Health Research, University of Southern Denmark, Denmark; [4] Danish Hip Arthroplasty Register; [5] Department of Orthopaedic Surgery and Traumatology, Copenhagen University Hospital, Bispebjerg, University of Copenhagen, Denmark; Department of Clinical Medicine, Faculty of Health and Medical Sciences, Denmark; [6] Department Orthopaedics, Leiden University Medical Center, Leiden, Netherlands; [7] Department of Clinical Medicine, Aarhus University, Aarhus, Denmark
Correspondence: nme@clin.au.dk
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Background and purpose — Patients receiving a total hip arthroplasty (THA) are subsequently at an increased risk of cardiovascular disease (CVD). Further, socioeconomic status (SES) has an effect on CVD. We evaluated whether low SES is associated with a higher risk of readmission due to CVD after THA within 90 days in a setting with universal tax-supported healthcare.

Patients and methods — We performed a nationwide population-based cohort study using Danish health registries from 1995 to 2017. Individual-based information on SES markers (cohabitation, education, income, and liquid assets) was obtained for all participants. The outcome was any hospital-treated CVD. The data was transformed using the pseudo-observation method to enable an estimation of the adjusted risk ratios (RRs) with 95% confidence intervals (CI) for each marker using generalized linear regression.

Results — Among 103,286 THA patients, 452 were hospitalized with CVD within 90 days after surgery. Low SES seemed to be associated with a small increased risk of CVD, as the RRs for any CVD were 1.1 (95% CI 0.7–1.7) for patients living alone vs. cohabiting, 1.3 (CI 0.7–2.3) for low education vs. high, 1.4 (CI 0.8–2.6) for low income vs. high, and 1.3 (CI 0.8–2.1) for low liquid assets vs. high.

Conclusion — Living alone, low education, low income, and low liquid assets seem to be associated with a small increased risk of readmission due to CVD 90 days after THA. Wide confidence intervals in risk should be considered when interpreting the study results.

Patients receiving a total hip arthroplasty (THA) have an increased risk of cardiovascular diseases (CVD), in particular during the immediate postoperative period. The estimated additional risk compared with the general population is 0.74% for venous thromboembolism (VTE), 0.59% for deep-vein thrombosis (DVT), and 0.17% for pulmonary embolism (PE) within the first 90 days after surgery (1). The potential mechanisms are cardiac and hemodynamic stressors associated with the surgery along with fat embolization, which is most prominent for cemented implants (2-4). Low socioeconomic status (SES) is in general associated with the risk of CVD (5). Potential explanations are biological, behavioral, and psychosocial risk factors prevalent in disadvantaged individuals, which emphasizes the link between SES and CVD (5).

However, contradictory results regarding the association between SES and CVD after THA have been reported (2,6-8). This discrepancy could be due to differences in socioeconomic background of study populations, definition of SES markers and choice of markers, or inconsistency in statistical modelling as well as study size. To our knowledge, no previous study has quantified the absolute risk of CVD after THA or evaluated the risk of CVD after THA in relation to CVD history by SES markers. In addition, none of the previous studies have stratified on different CVDs, which could be of importance, as the etiology, risk factors, and treatment behind various CVDs differ. Therefore, we studied the risk of readmission due to CVD after THA, while distinguishing between AMI (acute myocardial infarction), DVT (deep vein thrombosis), PE (pulmonary embolism), and stroke within 90 days after THA by using individual-based data in a setting with universal tax-supported healthcare. We hypothesize that there is socioeconomic inequality in the risk of CVD after THA in Denmark.

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Patients and methods

Study design and setting

In Denmark, all citizens are assigned a unique civil registration number at birth, which is included in all Danish registries, allowing unambiguous individual-level record linkage between population-based and prospectively collected data from all registries, enabling complete long-term follow-up of all Danish inhabitants.

We used the following registries:

(1) The Danish Civil Registration System, which holds data on vital status, migrations, cohabitation status, age, and sex.

(2) The Danish Hip Arthroplasty Registry, which holds information on primary and revision THA (9). We collected information regarding the type of surgery, surgery side, primary diagnosis, date of surgery, and hospital code.

(3) The Danish National Patient Registry, which contains discharge dates and diagnoses from all hospitalizations since 1977, and outpatient clinic and emergency room contacts since 1995. We collected data for each patient on comorbidity history and on CVD diagnoses. As previous research has demonstrated, a 10-year look-back period is adequate, when summarizing pre-surgery hospital comorbidity history for each patient. We measured the comorbidity status by Charlson Comorbidity Index (CCI) score. Patients were classified in one of the 3 levels of the CCI score: low (a score of 0); medium (a score of 1–2); and high (a score of 3 or more).

(4) Statistics Denmark holds socioeconomic data on all Danish citizens. For each THA patient, we retrieved information on SES using the following markers:
- Cohabitating status was classified into 2 categories: living alone and cohabiting.
- Highest obtained education was classified into 3 categories: low, defined as none or elementary school; medium, defined as more than elementary school, but less than university completed; and high, defined as university degree completed.
- Family income and liquid assets were attained for the 5 years prior to surgery. As a large proportion of the THA patients are senior citizens with a state pension, family liquid asset was added as an SES. To account for yearly variations in income and liquid assets, we calculated the average yearly total income and liquid assets in the 5 years prior to the THA surgery for the patient and the patient's cohabiting partner. To account for inflation during the long study period, we grouped all mean income and mean liquid assets by year, and finally categorized them into 3 groups of increasing amount according to tertiles: low, medium, and high.

(5) The Danish National Health Service Prescription Database, which holds data on all prescriptions for reimbursed drugs dispensed by community pharmacies in Denmark since 2004. For each THA patient, we retrieved information on any dispensed CVD medication (yes vs. no) 1 year prior to the date of surgery (Table 1, see Supplementary data).

Study population and outcome

We identified all patients over the age of 45 undergoing primary THA in Denmark from January 1, 1995 to December 31, 2017 with a primary diagnosis of idiopathic osteoarthrosis (completeness of DHR 91–98%) (9). We included only the first THA during 1995–2017 in the study cohort to avoid dependency of observations. Patients exceeding 90.1 years of age were excluded as outliers, following the conventional outlier definition of 1.5 standard deviations above the 75th percentile.

We defined a composite outcome as the first readmission or first visit to an outpatient clinic due to any hospital-treated CVD, whichever came first, and specified outcomes, as the first readmission or first visit to an outpatient clinic due to either MI, VTE, DVT, stroke, or PE. The validity of CVD is in general high, with a positive predictive value (PPV) of 88–97% for MI and 70–90% for VTE (11). The PPV for stroke was 43–87% (12).

Statistic

The 90-day cumulative incidence of any hospital-treated CVD, as well as AMI, VTE, DVT, stroke, and PE was calculated for all 4 markers, starting follow-up at the date of primary THA. In our combined endpoint, the possible events were any hospital-treated CVD. In the subsequent subgroups, the possible events were the first hospital-treated CVD for each specific outcome in the respective analysis. Death was treated as competing risk. Cumulative incidence at 90 days was plotted for any hospital-treated CVD, stratified by cohabitation, education, income, and liquid assets.

The main analysis was the 90-day risk differences (RD) and risk ratios (RRs) with 95% confidence intervals (CI) for all outcomes, which are presented in forest plots for each marker. Data was transformed according to the pseudo-observation method and analyzed via generalized linear regression (13). Crude and adjusted RD and RR are presented in tables, when adjusting for potential confounders; age, sex, CCI, cardiac-related medication, and a hospital group covariate. The directed acyclic graph method was used to select confounder variables. Only cohabiting status was evaluated as a confounder when calculating the RR and RD for CVD for income and liquid assets. As hospital volume has an impact on the risk of adverse effect, the hospital covariate was constructed accordingly (14). An average number of THA surgeries performed in each hospital per year was calculated, excluding the years where the hospital had zero procedures. Hospitals were categorized according to annual volume and grouped as followed: the lowest 40th percentile, between the 41st and 80th percentile, and the highest 20th percentile. We considered the SES markers' interdependency. A mutual adjustment for each

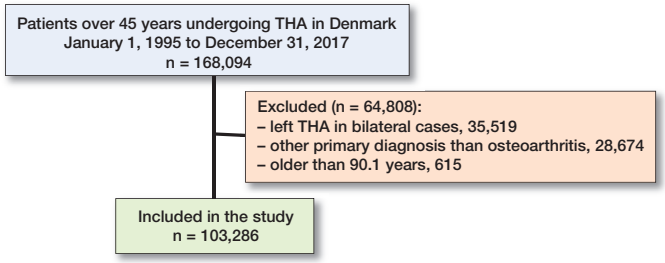

Figure 1. Flowchart of final primary total hip arthroplasty (THA) cohort.

SES marker would assume no effect of the common aspects of the SES markers, concluding that all effects are due to unique characteristics of the different SES markers (15). We therefore did not mutually adjust. A sensitivity analysis was performed by stratifying on CVD history to account for the different risk profiles in patients with different CVD history.

This paper was reported following the STROBE and RECORD guidelines. The statistical analyses were performed in STATA version 16 (STATACorp, College Station TX, USA) and R version 4.1.0 (R Foundation for Statistical Computing, Vienna, Austria).

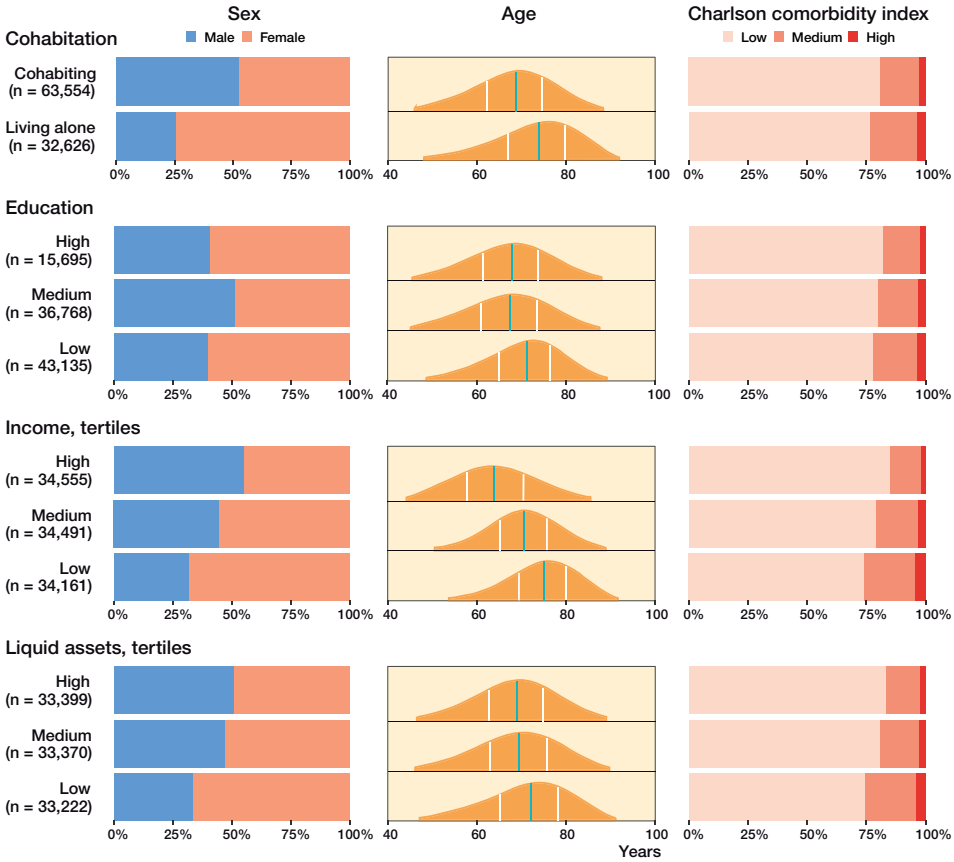

Figure 2. Demographics. Distribution of sex, age, and Charlson comorbidity index score in the 4 SES markers. Sex: Distribution of females and males given in percentages marked on the x-axis. Age: Green line marks the median age and the white lines marks the quantiles. Age is marked on the x-axis. Charlson comorbidity index score: Distribution of the scores given in percentages marked on the x-axis. n: number of THA. Total n = 103,286.

Ethics, funding, data sharing, and disclosures

The study was approved by the Danish Data Protection Agency (journal number 2015-57-0002) and Aarhus University (journal number 2016-051-000001). We would like to acknowledge the support from Helsefonden, the Orthopaedic Research Fund, the AP Møller Fund, and the Aase and Ejnar Danielsens Fund. Data is not available for sharing. The funders had no role in the study design, data collection and analysis, or in the preparation of the manuscript. The authors report no conflict of interest.

Results

Descriptions of the study population

The final study population included 103,286 THA patients (Figure 1), and the stratification of the study population yielded 2,905 with and 100,381 without prior CVD (Table 2, see Supplementary data). The median follow-up was 9 years (0–23) for any CVD. Several patient characteristics were unevenly distributed among the SES markers and were as follows. The proportion of women ranged between 45% and 74%, being highest among patients living alone, and those with the lowest education, the lowest income, and the lowest liquid assets status. The mean age ranged between 64 and 74 years across the different SES markers and categories. The prevalence of a high CCI score ranged from 2% to 4%, being higher among patients living alone, and in those with the lowest education, the lowest income, and the lowest liquid assets (Figure 2 and Table 3, see Supplementary data).

Socioeconomic status and CVD

Within 90 days after primary THA, 452 patients (0.4% of the entire study population) were hospitalized with any cardiovascular event.

Cumulative incidence

Overall, the cumulative incidence of any CVD within 90 days of THA was highest among patients living alone (0.7; CI 0.6–0.7), patients with the lowest education (0.5; CI 0.5–0.5), patients with the lowest income (0.7; CI 0.6–0.8), and those with the lowest liquid assets (0.6; CI 0.5–0.7) (Figure 3 and Table 4).

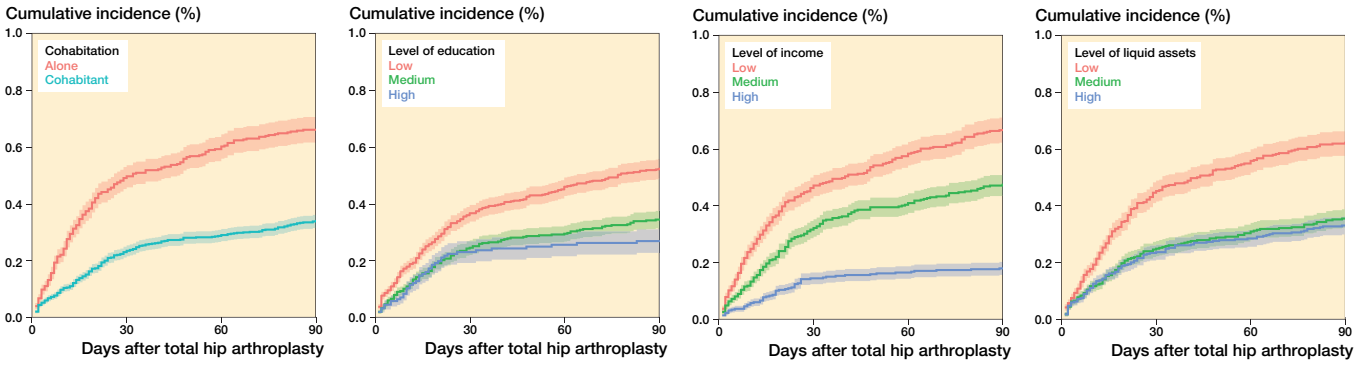

Figure 3. Cumulative incidence for any CVD at 90 days after THA for cohabitation, level of education, level of income, and level of liquid assets.

Table 4. Cumulative incidence (%) of CVD at 90 days with 95 % confidence interval (CI)

	Any CVD	CVD type AMI	VTE	DVT	Stroke	PE
Cohabitation status						
Alone	0.7 (0.6–0.7)	0.1 (0.1–0.2)	0.4 (0.3–0.5)	0.3 (0.2–0.3)	0.2 (0.1–0.2)	0.1 (0.1–0.2)
Cohabitant	0.3 (0.3–0.4)	0.1 (0.1–0.1)	0.2 (0.1–0.2)	0.1 (0.1–0.1)	0.1 (0.1–0.1)	0.0 (0.0–0.1)
Education						
Low	0.5 (0.5–0.6)	0.1 (0.1–0.1)	0.3 (0.2–0.3)	0.2 (0.1–0.2)	0.1 (0.1–0.2)	0.1 (0.1–0.1)
Medium	0.3 (0.3–0.4)	0.1 (0–0.1)	0.2 (0.2–0.3)	0.1 (0.1–0.2)	0.1 (0.0–0.1)	0.1 (0.0–0.1)
High	0.3 (0.2–0.3)	0.1 (0–0.1)	0.2 (0.1–0.2)	0.1 (0.1–0.2)	0.0 (0.0–0.1)	0.0 (0.0–0.1)
Income						
Low	0.7 (0.6–0.8)	0.2 (0.1–0.2)	0.4 (0.3–0.4)	0.3 (0.2–0.3)	0.2 (0.1–0.2)	0.1 (0.1–0.1)
Medium	0.5 (0.4–0.5)	0.1 (0.1–0.1)	0.3 (0.2–0.3)	0.2 (0.1–0.2)	0.1 (0.1–0.1)	0.1 (0.0–0.1)
High	0.2 (0.1–0.2)	0.0 (0.0–0.1)	0.1 (0.1–0.2)	0.1 (0–0.1)	0.0 (0.0–0.0)	0.0 (0.0–0.1)
Liquid assets						
Low	0.6 (0.5–0.7)	0.1 (0.1–0.2)	0.4 (0.3–0.4)	0.3 (0.2–0.3)	0.2 (0.1–0.2)	0.1 (0.0–0.1)
Medium	0.4 (0.3–0.4)	0.1 (0.1–0.1)	0.2 (0.1–0.2)	0.1 (0.1–0.1)	0.1 (0.0–0.1)	0.1 (0.0–0.1)
High	0.3 (0.3–0.4)	0.1 (0.0–0.1)	0.2 (0.1–0.2)	0.1 (0.1–0.2)	0.1 (0.0–0.1)	0.1 (0.0–0.1)

CVD: Cardiovascular disease; AMI: Acute myocardial infarction; VTE: Venous thromboembolism.
DVT: Deep vein thrombosis; PE: Pulmonary embolism.

Among patients with prior CVD, the cumulative incidence was highest among patients living alone (5.1; CI 3.9–6.4), patients with a medium education (5.5; CI 3.8–6.4), patients with a medium income (5.7; CI 4.2–7.1), and those with lowest liquid assets (5.6; CI 4.3–6.8) (Figure 4, see Supplementary data). Among patients without prior CVD, the cumulative incidence estimates were similar to the overall estimates (Figure 5, see Supplementary data).

Relative risk

Within 90 days of follow-up, the RR for any CVD was 1.1 (CI 0.7–1.7) for patients living alone compared with cohabiting patients. In addition, the RR was 1.3 (CI 0.7–2.3) for patients with the lowest compared with the highest level of education, 1.4 (CI 0.8–2.6) for patients with the lowest compared with the highest income, and 1.3 (CI 0.8–2.1) for patients with the lowest compared with the highest liquid assets (Figure 6 and Table 5, see Supplementary data).

A similar trend was seen when evaluating the association between all 4 SES markers and stroke, where higher RRs were found in the most deprived (i.e., living alone, low education, low income, and low liquid assets) (Figure 6 and Table 6, see Supplementary data).

The results for AMI, VTE, DVT, and PE as separate outcomes deviated slightly compared with the overall results for any CVD. The trend of higher RRs in the most deprived was not consistent for all outcomes and SES markers (Figure 6 and Table 6, see Supplementary data).

Influence of previous CVD

When stratifying on CVD history, the RRs for any CVD pointed in the same direction for all 4 SES markers as seen in the main analysis. However, the magnitude of the RRs was larger when only including patients with prior CVD (Figures 7–11, see Supplementary data).

The RD estimates were in general small. However, when stratifying patients with or without prior CVD, the RDs became substantial among patients with prior CVD (Figure 12, see Supplementary data).

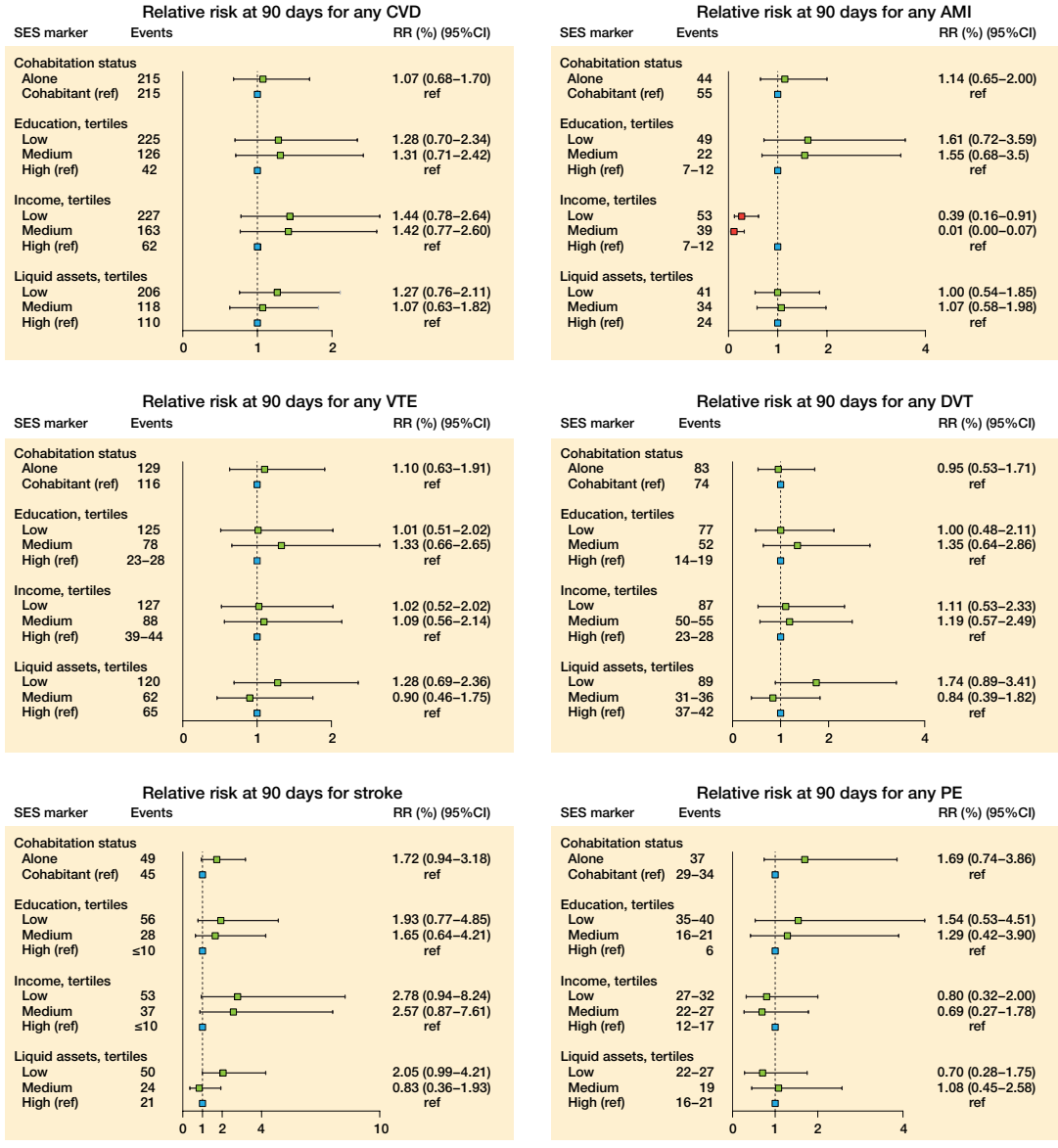

Figure 6. Relative risk for cardiovascular disease (CVD), acute myocardial infarction (AMI), venous thromboembolism (VTE), deep-vein thrombosis (DVT), stroke, and pulmonary embolism (PE) at 90 days postoperative THA.

Discussion

We showed that at 90 days postoperatively the most socioeconomically deprived patients seemed to experience a small increased risk of readmission due to any CVD and due to stroke, although the point estimates were uncertain and related to wide CI, and the absolute RDs were small.

SES markers and the risk of readmission due to CVD

As in our study, Hassen et al. found a higher risk of CVD in patients with no social support, lowest level of education, and lowest level of wealth, although localized only to a non-THA population (16). Cohabitation has been proposed as an unconventional risk factor, as differences in cardiovascular events and mortality have been observed among married and unmarried individuals, where marriage has a protective role (17). When living alone, missing out on social support may lead to increased stress during the postoperative rehabilitation period after the THA. This type of stress has been shown to worsen cardiovascular risk factors such as hypertension and progression of atherosclerosis (17). Further, the decreased risk of CVD seen in cohabiting individuals may also be due to early recognition of changes in health, improved adherence, and encouraged promotion of healthy behaviors from cohabiting partners (17). In accordance with our results, chronic social stress induced by lower income and lower educational achievement can further enhance the risk of CVD (18).

2 studies found no difference in postoperative complications between deprivation categories concerning AMI, DVT, and PE (2,19). However, when evaluating SES by independent markers and not by a combined estimation, other studies accord with us, showing that a lower level of education and income is associated with a higher risk of CVDs after THA (6,7).

The association between SES and CVDs is not consistent throughout all of our specific CVDs. For instance, the opposite trend is present in some SES markers, like low income, which is associated with a decreased risk of AMI. Difference in awareness of AMI symptoms has been evident, of which individuals with lower income have been observed to be less aware than individuals with higher income, and that their response to symptoms is more inappropriate too (20). This would result in a lower registered incidence of AMI for patients with a low income than those with a high income. The lower incidence would be enhanced by the inappropriate response to AMI resulting in premature death and an increased mortality in patients with low income, which actually is the case in this population, thereby introducing a differential misclassification (21).

Stress seems to be the common denominator for all SES markers. The psychological burden of being poor is explained by the biology of chronic stress in the sense that income inequality acts as a social stressor by lower levels of social cohesion and generalized trust. When living alone, missing out on social support may lead to increased stress during the postoperative rehabilitation period after the THA. This type of stress has been shown to worsen cardiovascular risk factors such as hypertension and progression of atherosclerosis. Chronic social stress induced by lower income and lower educational achievement can therefore further increase the risk of CVD (17,18,22).

A socioeconomic gradient has been documented in health indicators measured across different life stages in the United States (18). The United States is known to have large socioeconomic differences, thus making differences between SES stratifications easier to detect (23). Observing a graded relationship of SES markers with the risk of CVD in the Danish population suggests a possible dose–response relationship, as opposed to a simple absolute threshold like a static poverty threshold. The association could therefore be more pronounced in societies with larger socioeconomic inequalities and in a setting in which basic needs are not met (18,22).

Strengths and limitations

Our study has several strengths. First, it is based on prospectively collected nationwide data where information on CVD outcome, medication, and SES markers was collected from registries at an individual patient level with virtually no missing data. Second, the inclusion of cardiac-related medications as a covariate is an advantage, as a previous history of CVD is a confounder (3). Furthermore, multiple SES markers were uniquely available in our study, which is a strength, as the individual markers make sizable independent and distinct contributions to health (24). In addition, including liquid assets as an SES marker provides us with a more accurate estimation of SES in a population with a mean age over the age of retirement, as liquid assets can reflect a lifetime of deprivation or wealth. However, acknowledging this, stratification on age could enhance our results, enabling an even more accurate estimation by using income when assessing patients < 65 years and using liquid assets when assessing patients > 65 years. Due to too few events, however, this was not possible.

We did not include fixation technique of the THA as a variable, although fixation technique influences the risk of CVD (4). While the proportion of cemented THAs is higher in the most deprived patients (Table 3, see Supplementary data), patient SES does not determine which fixation technique is used. This would be the patient's age instead, as cemented THA is the preferred choice in older patients and cementless in younger due to differences in survival in relation to age (25). Including age in the analysis should therefore be sufficient.

We were not able to calculate adjusted RRs for DVT and PE in patients with prior CVD because of too few events. Further, we cannot eliminate the possibility of residual or unmeasured confounding, as we have no information regarding lifestyle factors, such as BMI, smoking, and physical activity. These factors are strongly socially patterned and most prevalent in the lower SES stratifications and are all known risk factors for CVD (26). Although data validity of CVD is generally high, the validity for stroke is low (12).

In conclusion, living alone, low education, low income, and low liquid assets were all associated with slightly higher risks of readmission due to any CVD within the first 90 days after THA. We cannot change a patient's SES, but by increasing the knowledge concerning SES and CVD after THA, public health initiatives in the form of patient, surgeon, and policy practice may be developed with a specific focus on the most vulnerable patients. Even though cohabitation status is a non-modifiable risk factor, it could be an example of changing policy practice—aspects of social support exist that could be targeted within clinical settings. Group-based rehabilitation is often positively received, as it offers the opportunity to meet people at a similar stage of recovery. This of course comes at a cost. However, it has been estimated that optimization of social care provision for patients living alone could lead to cost savings by reducing the length of hospital stay and reducing rates of readmission (27). As eliminating socioeconomic disadvantage from society is difficult and may take years, quantifying modifiable intermediate factors and targeting them could therefore have important public health benefits, and, even more, will benefit individual patients.

NME drafted the manuscript. NME, EBK, RGHHN, CV, SO, and AP conceived and designed the study, interpreted the results, and revised the manuscript.

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Supplementary data

Table 1. CVD diagnosis codes and ATC codes

CVD	ICD-10	ATC
AMI	DI200, DI21	Lipid-lowering drugs: C10
VTE	I800, I808C, I821, I81, I820, K550H, I823, I822, I808B, I828, I829, DI26, DI801-3, 45099	Antihypertensive drugs: C02, C03, C04, C07, C08, C09 Antithrombotic drugs: B01 Anti-arrhythmic drugs: C01, C05
DVT	DI801-3	
Stroke	DI63, DI64, DI60, DI61, DG45	
PE	DI26, 45099	
CVD	All the above	

CVD: Cardiovascular disease; AMI: Acute myocardial infarction; VTE: Venous thromboembolism.
DVT: Deep-vein thrombosis; PE: Pulmonary embolism.

Table 2. Stratification of the study population

	Any CVD	AMI	VTE	DVT	Stroke	PE
No prior history						
Cohabitation	93,414	95,125	95,523	95,775	94,904	95,998
Education	92,941	94,578	94,963	95,205	94,378	95,419
Income	100,302	102,106	102,512	102,775	101,861	103,015
Liquid assets	97,176	98,920	99,320	99,574	98,689	98,808
Total	100,381					
Prior history						
Cohabitation	2,766	1,055	657	405	1,276	182
Education	2,657	1,020	635	393	1,220	179
Income	2,905	1,101	696	432	1,346	192
Liquid assets	2,815	1,071	671	417	1,302	183
Total	2,905					

Study population by which the stratified analyses are based on. Any CVD is stratified into ± previous CVD specified for each marker. AMI is stratified into ± previous AMI specified for each marker. VTE is stratified into ± previous VTE specified for each marker. DVT is stratified into ± previous DVT specified for each marker. Stroke is stratified into± previous stroke specified for each marker. PE is stratified into ± previous PE specified for each marker.
For abbreviations, see Table 1.

Table 3. Demographic characteristics. Values are count (%)

	Cohabiting status			Education			Income			Liquid assets		
	Alone	Cohabiting	Other	Low	Medium	High	Low	Medium	High	Low	Medium	High
Sex												
Female	24,261 (74)	30,021 (47)	3,574 (50)	25,915 (60)	17,809 (48)	9,321 (59)	23,238 (68)	19,077 (55)	15,497 (45)	22,125 (67)	17,606 (53)	16,338 (49)
Male	8,365 (26)	33,533 (53)	3,535 (50)	17,220 (40)	18,959 (52)	6,374 (41)	10,923 (32)	15,414 (45)	19,058 (55)	11,097 (33)	15,764 (47)	17,061 (51)
Age												
Mean (SD)	72.83 (9.3)	68.22 (8.8)	66.65 (9.3)	70.54 (8.4)	67.11 (9)	67.54 (8.9)	74.29 (8.0)	70.28 (7.9)	64.20 (8.9)	71.14 (9.4)	68.98 (9.2)	68.50 (8.8)
45–55	1,842 (6)	6,198 (10)	965 (14)	2,556 (6)	4,585 (12)	1,722 (11)	843 (2)	1,492 (4)	6,649 (19)	2,461 (7)	3,127 (9)	3,028 (9)
56–65	5,408 (17)	18,189 (29)	2,483 (35)	9,407 (22)	11,494 (31)	4,830 (31)	4,201 (12)	8,234 (24)	13,623 (39)	6,781 (20)	8,999 (27)	9,615 (29)
66–75	11,916 (37)	26,659 (42)	2,417 (34)	19,380 (45)	14,476 (39)	6,360 (41)	13,675 (40)	16,551 (48)	10,743 (31)	12,861 (39)	13,214 (40)	13,879 (42)
76–85	11,643 (36)	11,732 (18)	1,138 (16)	10,975 (25)	5,830 (16)	2,592 (17)	13,619 (40)	7,562 (22)	3,318 (10)	9,865 (30)	7,302 (22)	6,315 (19)
> 86	1,817 (6)	776 (1)	106 (1)	817 (2)	383 (1)	191 (1)	1,823 (5)	652 (2)	222 (1)	1,254 (4)	728 (2)	562 (2)
Charlson comorbidity score												
Low	24,928 (76)	51,334 (81)	5,807 (82)	33,645 (78)	29,432 (80)	12,889 (82)	25,283 (74)	27,262 (79)	29,455 (85)	24,846 (75)	26,964 (81)	27,851 (83)
Medium	6,496 (20)	10,412 (16)	1,126 (16)	7,995 (19)	6,214 (17)	2,421 (15)	7,410 (22)	6,144 (18)	4,470 (13)	6,973 (21)	5,543 (17)	4,819 (14)
High	1,202 (4)	1,808 (3)	176 (2)	1,495 (3)	1,122 (3)	385 (2)	1,468 (4)	1,085 (3)	630 (2)	1,403 (4)	863 (3)	729 (2)
Fixation technique												
Cemented	11,008 (34)	15,612 (25)	1,857 (26)	14,345 (33)	6,696 (18)	2,541 (16)	12,585 (37)	9,699 (28)	6,178 (18)	9,956 (30)	9,428 (28)	8,002 (24)
Uncemented	13,470 (41)	35,578 (56)	3,884 (55)	18,833 (44)	23,032 (63)	10,136 (65)	13,336 (39)	17,597 (51)	21,948 (64)	15,309 (46)	17,555 (53)	18,612 (56)
Hybrid	7,855 (24)	11,800 (19)	1,315 (19)	9,565 (22)	6,723 (18)	2,874 (18)	7,922 (23)	6,882 (20)	6,153 (18)	7,633 (23)	6,102 (18)	6,512 (20)
Other	173 (1)	335 (1)	31 (0)	231 (1)	196 (1)	94 (1)	201 (1)	180 (1)	155 (0)	174 (1)	190 (1)	156 (0)
Missing	120 (0)	229 (0)	22 (0)	161 (0)	121 (0)	50 (0)	117 (0)	133 (0)	121 (0)	150 (0)	95 (0)	117 (0)

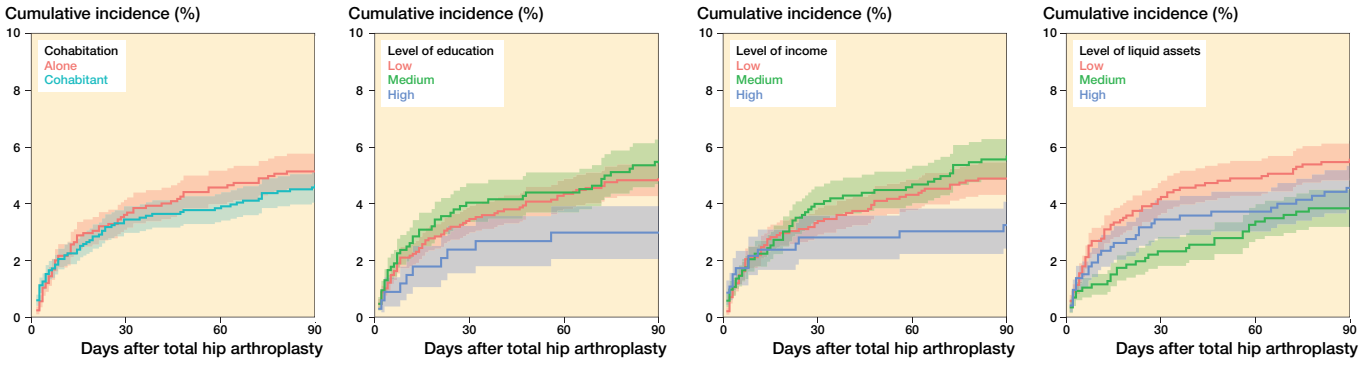

Figure 4. Cumulative incidence at 90 days for any CVD for patients with a prior history of CVD for cohabitation, level of education, level of income, and level of liquid assets.

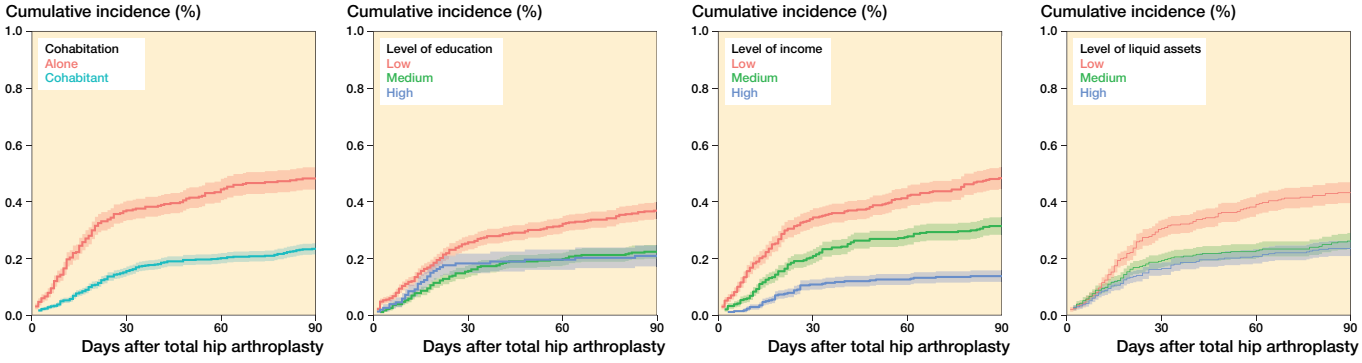

Figure 5. Cumulative incidence at 90 days for any CVD for patients without prior CVD for cohabitation, level of education, level of income, and level of liquid assets.

Table 5. Relative risk (RR) with 95% confidence interval for any CVD at 90 days

	Events	Crude RR	Adjusted RR
Cohabiting status			
Alone	215	2.0 (1.1–3.6)	1.1 (0.7–1.7)
Cohabitant	215	ref	ref
Education			
Low	225	2.0 (0.8–4.7)	1.3 (0.7–2.3)
Medium	126	1.3 (0.5–3.2)	1.3 (0.7–2.4)
High	42	ref	ref
Income			
Low	227	3.7 (1.5–9.0)	1.4 (0.8–2.6)
Medium	163	2.6 (1.1–6.5)	1.4 (0.8–2.6)
High	62	ref	ref
Liquid assets			
Low	206	1.9 (0.9–3.8)	1.3 (0.8–2.1)
Medium	118	1.1 (0.5–2.3)	1.1 (0.6–1.8)
High	110	ref	ref

CVD: Cardiovascular disease
ref = reference

Table 6. Crude relative risk (RR) and adjusted relative risk (aRR) with 95% confidence interval for acute myocardial infarction (AMI), venous thromboembolism (VTE), deep-vein thrombosis (DVT), stroke, and pulmonary embolism (PE) at 90 days

	AMI		VTE		DVT		Stroke		PE	
	RR	aRR	RR	aRR	RR	aRR	RR	aRR	RR	aRR
Cohabiting status										
Alone	1.6 (0.7–3.7)	1.1 (0.7–2.0)	2.2 (1.1–4.4)	1.1 (0.6–1.9)	2.2 (1.0–4.8)	1.0 (0.5–1.7)	2.1 (0.9–5.2)	1.7 (0.9–3.2)	2.3 (0.9–6.2)	1.7 (0.7–3.9)
Cohabitant	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Education										
Low	1.6 (0.5–5.2)	1.6 (0.7–3.6)	1.7 (0.7–4.6)	1.0 (0.5–2.0)	1.6 (0.6–4.9)	1.0 (0.5–2.1)	3.4 (0.7–16)	2.0 (0.8–4.9)	2.4 (0.6–11)	1.5 (0.5–4.5)
Medium	0.9 (0.2–3.1)	1.6 (0.7–3.5)	1.3 (0.5–3.5)	1.3 (0.7–2.7)	1.3 (0.4–4.0)	1.4 (0.6–2.9)	2.0 (0.4–9.9)	1.7 (0.6–4.2)	1.4 (0.3–6.2)	1.3 (0.4–3.9)
High	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Income										
Low	4.5 (1.1–18)	0.4 (0.2–0.9)	3.1 (1.2–7.9)	1.0 (0.5–2.0)	3.5 (1.2–11)	1.1 (0.5–2.3)	6.0 (1.2–29)	2.8 (0.9–8.2)	2.5 (0.7–8.6)	0.8 (0.3–2.0)
Medium	3.3 (0.8–13)	0.0 (0.0–0.1)	2.1 (0.8–5.5)	1.1 (0.6–2.1)	2.2 (0.7–6.8)	1.2 (0.6–2.5)	4.1 (0.9–20)	2.6 (0.9–7.6)	1.9 (0.5–6.6)	0.7 (0.3–1.8)
High	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Liquid assets										
Low	1.7 (0.6–4.8)	1.0 (0.5–1.9)	1.9 (0.9–4.1)	1.3 (0.7–2.4)	2.4 (1.0–5.8)	1.7 (0.9–3.4)	2.4 (0.8–6.9)	2.1 (1.0–4.2)	1.3 (0.5–3.8)	0.7 (0.3–1.8)
Medium	1.4 (0.5–4.1)	1.1 (0.6–2.0)	1.0 (0.4–2.3)	0.9 (0.5–1.8)	0.9 (0.3–2.6)	0.8 (0.4–1.8)	1.1 (0.4–3.7)	0.8 (0.4–2.0)	1.0 (0.3–3.0)	1.1 (0.5–2.6)
High	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref

ref: reference

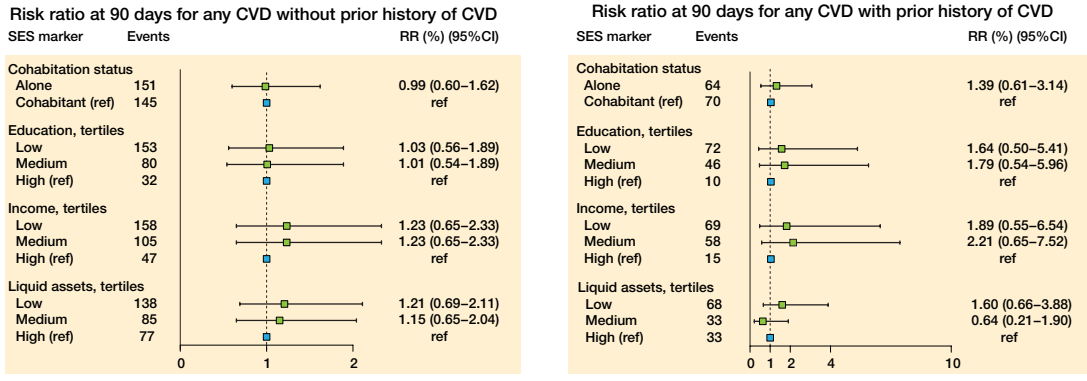

Figure 7. Relative risk at 90 days for any CVD for patients without a prior history of CVD (left panel), and for patients with a prior history of CVD (right panel).

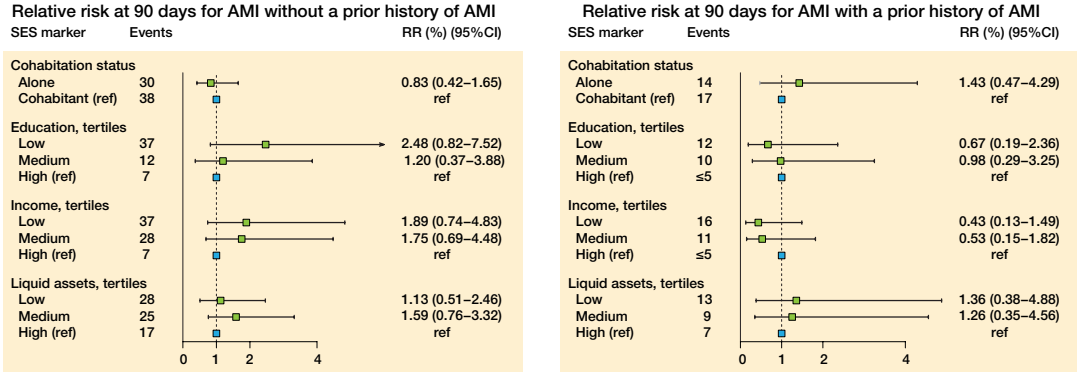

Figure 8. Relative risk at 90 days for AMI for patients without a prior history of AMI (left panel) and for patients with a prior history of AMI (right panel).

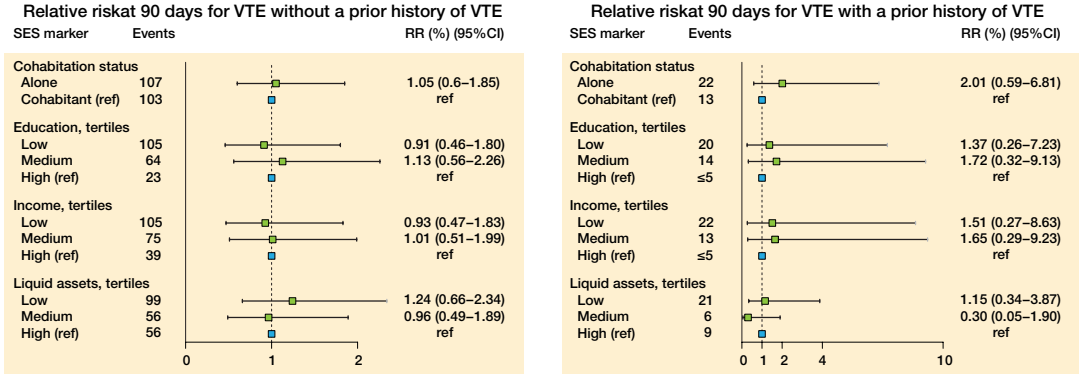

Figure 9. Relative risk at 90 days for VTE for patients without a prior history of VTE (left panel) and for patients with a prior history of VTE (right panel).

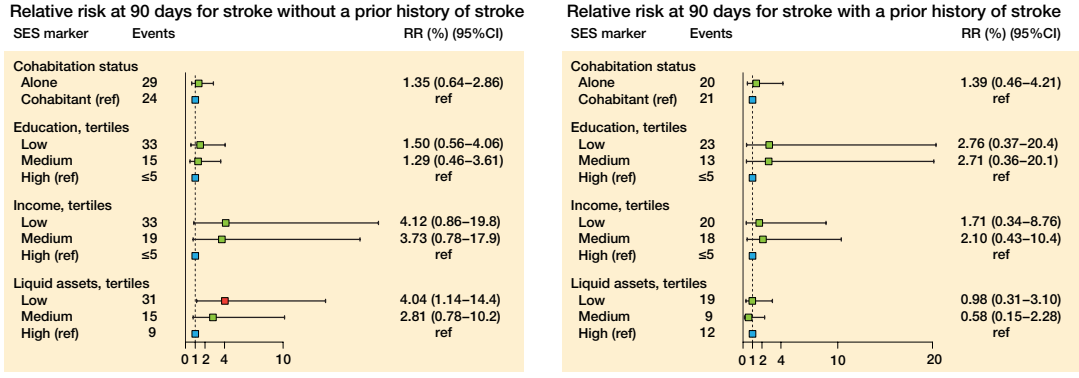

Figure 10. Relative risk at 90 days for stroke for patients without a prior history of stroke (left panel) and for patients with a prior history of stroke (right panel).

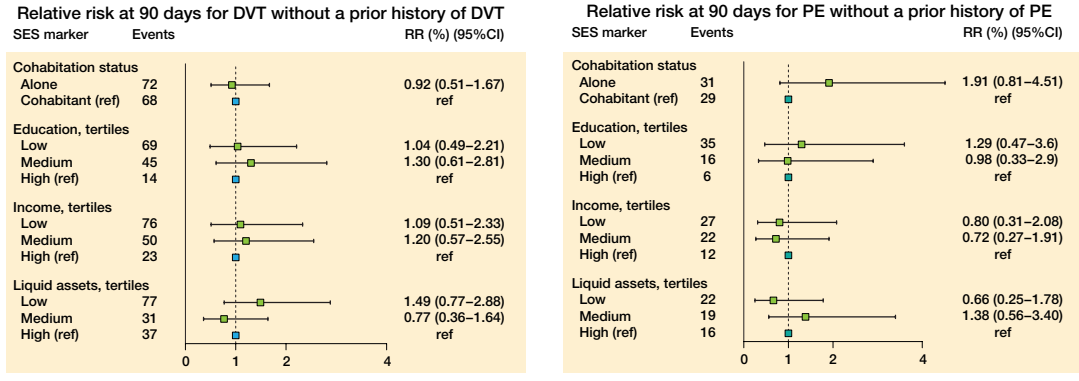

Figure 11. Relative risk at 90 days for DVT (left panel) and PE (right panel) for patients without a prior history of DVT and PE.

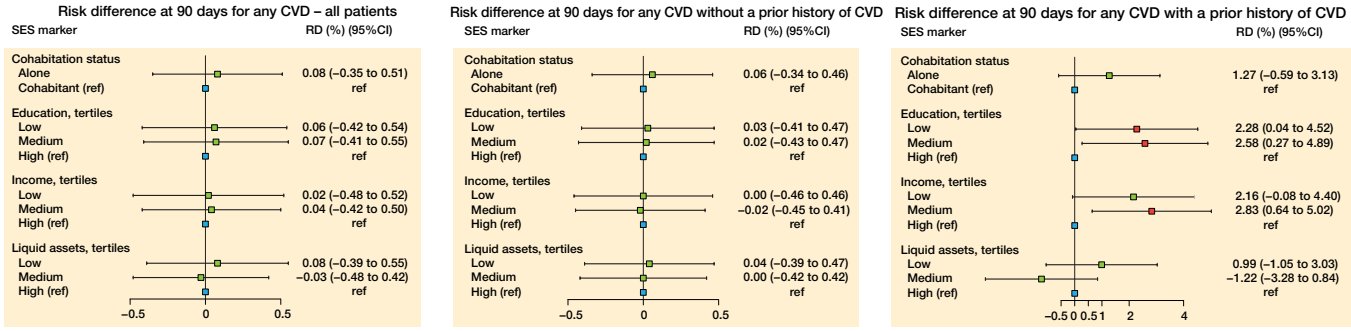

Figure 12. Risk difference (RD) at 90 days for cardiovascular disease (CVD) for the 4 markers foror all patients (left panel), for patients without a prior history of CVD (middle panel), and for patients with a prior history of CVD (right panel).