**Supplemental Material**

# Development and Validation of Long-Term Incident Heart Failure Risk Prediction Models

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## Online Tables

### Online Table I. Age-Adjusted Mean National Levels of Risk Factors by Sex-Race Group

| | Black | | White | |
|---|---|---|---|---|
| | **Men** | **Women** | **Men** | **Women** |
| **SBP for ages 18-39 years, mm Hg** | 121 (0.4) | 114 (0.5) | 118 (0.4) | 109 (0.3) |
| **SBP for ages 40-59 years, mm Hg** | 129 (0.8) | 128 (0.9) | 120 (0.5) | 124 (0.5) |
| **Treated SBP for ages 18-39 years, mm Hg** | 130 (2.7) | 129 (2.9) | 126 (1.7) | 119 (2.4) |
| **Treated SBP for ages 40-59 years** | 135 (1.6) | 133 (1.3) | 128 (0.9) | 127 (1.1) |
| **Mean BMI for ages 18-39 years, kg/m$^2$** | 28.3 (7.1) | 31.0 (8.4) | 27.5 (6.1) | 27.6 (7.3) |
| **Mean BMI for ages 40-59 years, kg/m$^2$** | 28.9 (6.7) | 32.3 (8.4) | 29.0 (6.1) | 28.9 (7.4) |
| **Mean total cholesterol, mg/dL (SD)** | 191 (188-193) | 192 (190-194) | 193 (191-195) | 200 (198-202) |
| **Mean HDL cholesterol, mg/dL (SD)** | 53 (52-54) | 59 (57-60) | 47 (46-48) | 58 (57-59) |

*Values are mean (95% confidence interval) and mean (standard deviation) and are derived from the NHANES 2013-2016 surveys
SBP = systolic blood pressure; BMI = body mass index; HDL = high-density lipoprotein;

## Online Table II. Overall Baseline Characteristics and by Cohort*

| | Overall N=24,838 | ARIC N=11176 | CARDIA N=5075 | MESA N=1882 | FHS N=1833 | FOF N=4872 | NHANES III '88-94 N=10623 | NHANES 2013-2016 N=6887 |
|---|---|---|---|---|---|---|---|---|
| **Mean age, years (SD)** | 43.5 (12.3) | 51.8 (4.1) | 25.3 (3.4) | 52.3 (4.2) | 52.3 (3.8) | 36.5 (9.4) | 36.5 (10.9) | 39.1 (11.3) |
| **Black, n (%)** | 6285 (25) | 2852 (26) | 2626 (52) | 807 (43) | 0 | 0 | 3502 (33) | 1443 (21) |
| **Female, n (%)** | 13565 (55) | 6218 (56) | 2770 (55) | 1013 (55) | 1031 (56) | 2533 (52) | 5759 (54) | 3509 (52) |
| **Diabetes, n (%)** | 1451 (6) | 1053 (9) | 35 (0.7) | 160 (9) | 70 (4) | 133 (3) | 492 (5) | 344 (5) |
| **Current smoking, n (%)** | 7865 (32) | 2852 (26) | 1571 (31) | 365 (19) | 878 (48) | 2199 (45) | 3240 (31) | 1526 (22) |
| **Mean systolic blood pressure, mm Hg (SD)** | 119 (18) | 120 (19) | 110 (11) | 120 (18) | 133 (19) | 121 (16) | 119 (15) | 119 (15) |
| **Hypertension treatment, n (%)** | 3664 (15) | 2852 (26) | 124 (2) | 518 (28) | 157 (9) | 13 (0.3) | 697 (7) | 879 (13) |
| **Mean total cholesterol, mg/dL (SD)** | 202 (43) | 212 (41) | 177 (33) | 193 (36) | 239 (44) | 196 (39) | 198 (42) | 190 (41) |
| **Mean HDL cholesterol, mg/dL (SD)** | 52 (16) | 52 (17) | 53 (13) | 51 (15) | 49 (15) | 51 (15) | 51 (15) | 52 (16) |
| **Mean BMI, kg/m$^2$** | 26.6 (5.3) | 27.7 (5.3) | 24.6 (5.2) | 29.3 (5.9) | 25.8 (4.2) | 25.3 (4.3) | 27.1 (6.0) | 29.2 (7.3) |

*Individual-level participant data pooled across 5 cohorts, which included ARIC, CARDIA, FHS, FOF, and MESA

#Values are mean (standard deviation)

**Online Table III. Median follow-up and crude event rate overall and by cohort***

| | Overall | ARIC | CARDIA | MESA | FHS | FOF |
|---|---|---|---|---|---|---|
| | **N=24,838** | **N=11176** | **N=5075** | **N=1882** | **N=1833** | **N=4872** |
| **Median follow-up** | 23.7 | 22.3 | 30.9 | 14.5 | 27.5 | 33.5 |
| **(IQR), years** | (17.5, 31.0) | (16.6, 23.4) | (30.7, 31.0) | (13.8, 14.9) | (18.8, 35.7) | (28.9, 35.0) |
| **Incident HF, n (%)** | 2384 (10) | 1557 (14) | 87 (2) | 45 (2) | 400 (22) | 295 (6) |
| **Non-HF related death, n (%)** | 4685 (19) | 2012 (18) | 390 (8) | 111 (6) | 1251 (68) | 921 (19) |

*Individual-level participant data pooled across 5 cohorts, which included ARIC, CARDIA, FHS, FOF, and MESA

## Online Table IV. Coefficients for the Covariates included in the Long-Term Incident Heart Failure Risk Prediction Model

| | White Male | | | | Black Male | | | |
|---|---|---|---|---|---|---|---|---|
| | HF | | Non-HF Death | | HF | | Non-HF Death | |
| | Coefficient | P value | Coefficient | P value | Coefficient | P value | Coefficient | P value |
| **Ln Age (y)** | 4.712 | $< 2x10^{-16}$ | 3.616 | $< 2x10^{-16}$ | 2.785 | $< 2x10^{-16}$ | 1.950 | $< 2x10^{-16}$ |
| **Ln Systolic BP (mm Hg)** | 1.828 | $3.2x10^{-13}$ | 1.903 | $< 2x10^{-16}$ | 2.954 | $1.6x10^{-12}$ | 1.770 | $2.2x10^{-7}$ |
| **Ln BMI (kg/m$^2$)** | 2.102 | $2.2x10^{-16}$ | -0.257 | 0.14 | 1.212 | 0.0011 | -0.940 | 0.0023 |
| **Ln total cholesterol (mg/dL)** | 0.428 | 0.025 | -0.211 | 0.090 | -0.022 | 0.94 | -0.116 | 0.61 |
| **Ln HDL cholesterol (mg/dL)** | -0.476 | 0.00014 | -0.017 | 0.83 | -0.398 | 0.058 | 0.256 | 0.12 |
| **Current smoker (1=Yes, 0=No)** | 0.622 | $< 2x10^{-16}$ | 0.709 | $< 2x10^{-16}$ | 0.634 | $1.6x10^{-7}$ | 0.659 | $1.2x10^{-12}$ |
| **Diabetes (1=Yes, 0=No)** | 0.945 | $< 2x10^{-16}$ | 0.342 | 0.00015 | 0.862 | $9.0x10^{-10}$ | 0.693 | $1.6x10^{-7}$ |
| **Antihypertension treatment (1=Yes, 0=No)** | 0.740 | $< 2x10^{-16}$ | 0.134 | 0.073 | 0.447 | 0.00048 | 0.001 | 0.99 |
| **C Statistic (SE)** | 0.82 (0.011) | | 0.75 (0.007) | | 0.84 (0.017) | | 0.72 (0.013) | |
| | **White Female** | | | | **Black Female** | | | |
| | HF | | Non-HF Death | | HF | | Non-HF Death | |
| | Coefficient | P value | Coefficient | P value | Coefficient | P value | Coefficient | P value |
| **Ln Age (y)** | 4.976 | $< 2x10^{-16}$ | 3.554 | $< 2x10^{-16}$ | 2.550 | $2.2x10^{-16}$ | 2.330 | $< 2x10^{-16}$ |
| **Ln Systolic BP (mm Hg)** | 1.501 | $1.0x10^{-9}$ | 1.351 | $1.5x10^{-14}$ | 2.296 | $1.3x10^{-11}$ | 2.036 | $9.2x10^{-10}$ |
| **Ln BMI (kg/m$^2$)** | 1.638 | $3.3x10^{-16}$ | -0.196 | 0.20 | 1.096 | $4.4x10^{-5}$ | -0.315 | 0.21 |
| **Ln total cholesterol (mg/dL)** | 0.125 | 0.49 | 0.202 | 0.12 | 0.708 | 0.0049 | 0.088 | 0.71 |
| **Ln HDL cholesterol (mg/dL)** | -0.378 | 0.0022 | -0.333 | 0.00010 | -0.572 | 0.0045 | -0.428 | 0.0204 |
| **Current smoker (1=Yes, 0=No)** | 0.608 | $< 2x10^{-16}$ | 0.726 | $< 2x10^{-16}$ | 0.644 | $1.4x10^{-8}$ | 0.596 | $8.9x10^{-9}$ |
| **Diabetes (1=Yes, 0=No)** | 0.923 | $9.9x10^{-16}$ | 0.733 | $2.5x10^{-12}$ | 1.305 | $< 2x10^{-16}$ | 0.208 | 0.16 |
| **Antihypertension treatment (1=Yes, 0=No)** | 0.506 | $1.0x10^{-8}$ | 0.320 | $1.1x10^{-5}$ | 0.320 | 0.0043 | 0.164 | 0.14 |
| **C Statistic (SE)** | 0.83 (0.011) | | 0.76 (0.008) | | 0.85 (0.015) | | 0.75 (0.014) | |

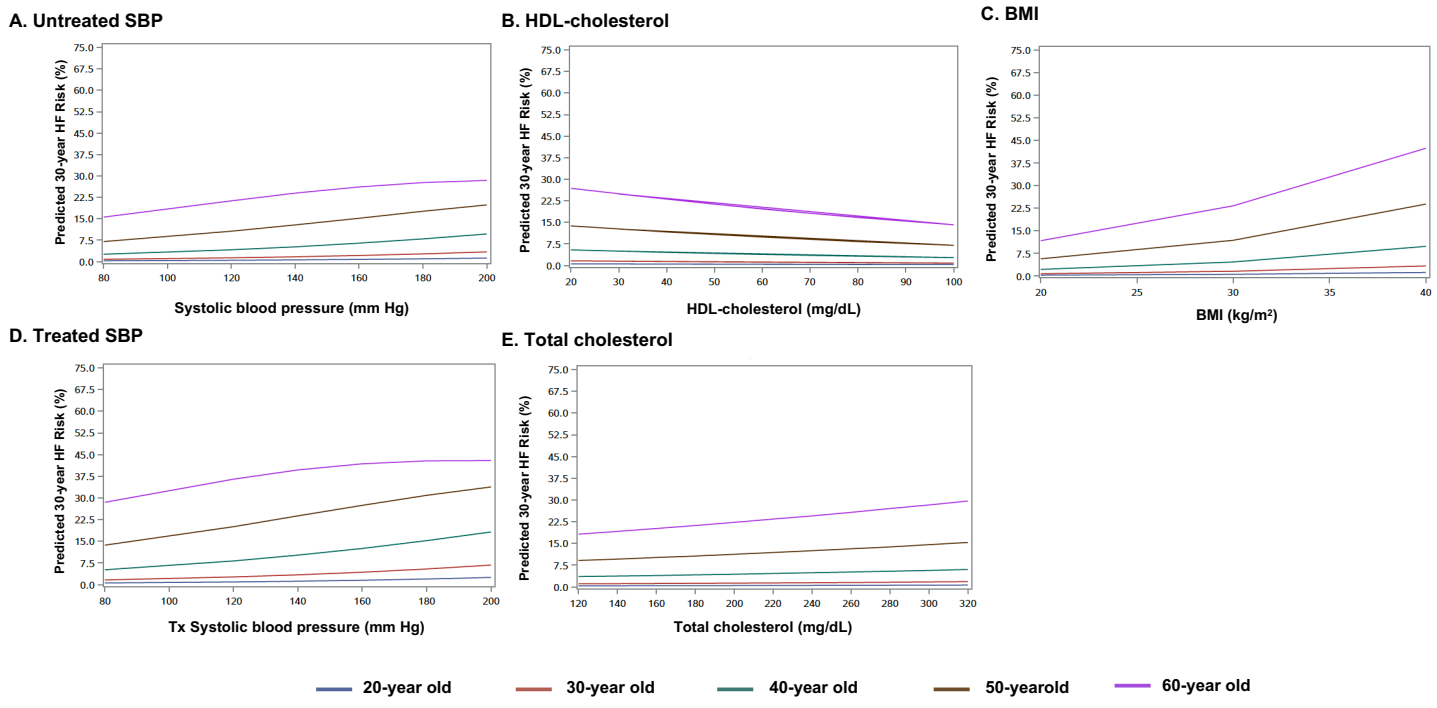
HF represents heart failure; BP blood pressure; BMI body mass index; HDL high density lipoprotein; SE standard error

**Online Table V. Coefficients for the Covariates for White Adults included in the Long-Term Incident Heart Failure Risk Prediction Model After Excluding Framingham Heart Study and Framingham Offspring Study**

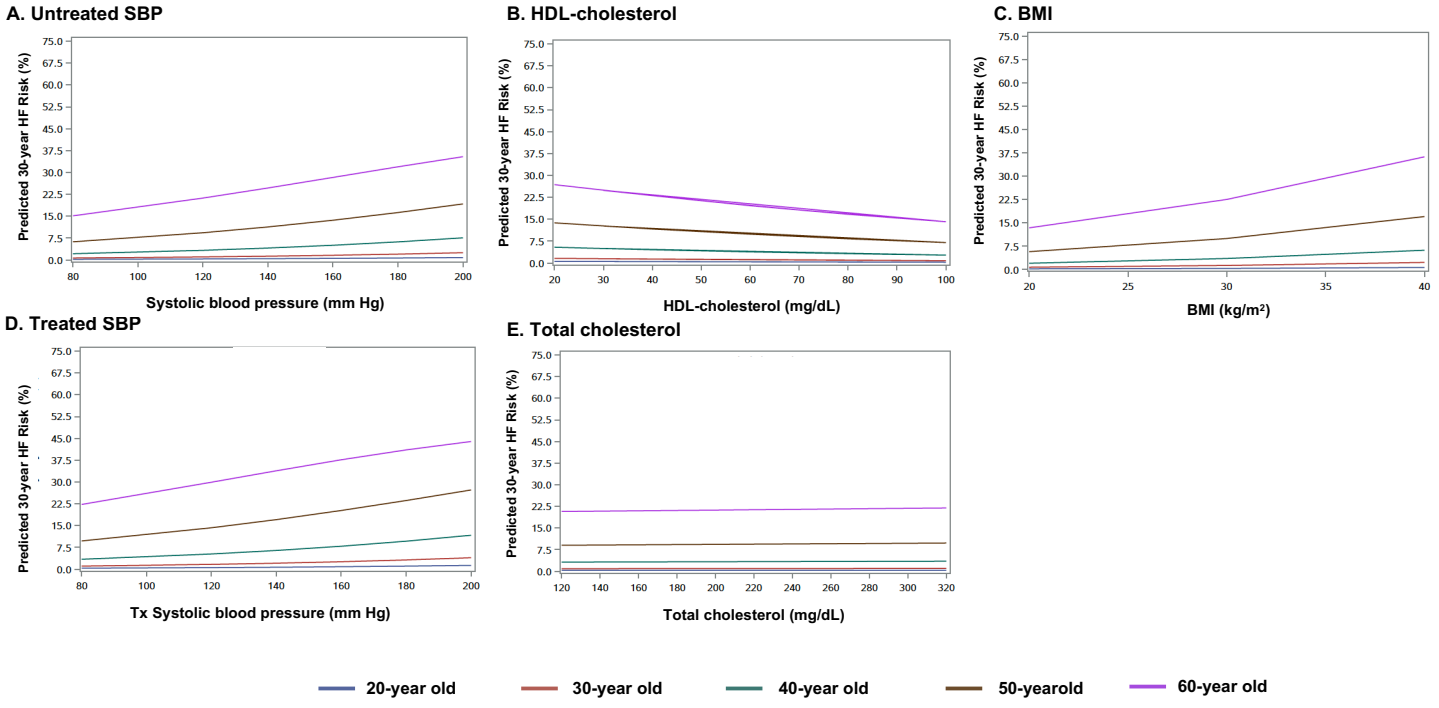
| | White Male | | | |
|---|---|---|---|---|
| | HF | | Non-HF Death | |
| | Coefficient | P value | Coefficient | P value |
| **Ln Age (y)** | 5.995 | $< 2x10^{-16}$ | 3.139 | $< 2x10^{-16}$ |
| **Ln Systolic BP (mm Hg)** | 2.099 | $2.2x10^{-9}$ | 1.708 | $7.0x10^{-10}$ |
| **Ln BMI ($kg/m^2$)** | 1.933 | $1.7x10^{-9}$ | -0.422 | 0.11 |
| **Ln total cholesterol (mg/dL)** | 0.373 | 0.13 | -0.504 | 0.0059 |
| **Ln HDL cholesterol (mg/dL)** | -0.319 | .059 | 0.108 | 0.41 |
| **Current smoker (1=Yes, 0=No)** | 0.868 | $< 2x10^{-16}$ | 0.791 | $< 2x10^{-16}$ |
| **Diabetes (1=Yes, 0=No)** | 0.938 | $1.4x10^{-15}$ | 0.379 | .0025 |
| **Antihypertension treatment (1=Yes, 0=No)** | 0.621 | $2.1x10^{-10}$ | 0.223 | 0.010 |
| **C Statistic (SE)** | 0.82 (0.013) | | 0.72 (0.01) | |
| | **White Female** | | | |
| | **HF** | | **Non-HF Death** | |
| | Coefficient | P value | Coefficient | P value |
| **Ln Age (y)** | 4.931 | $< 2x10^{-16}$ | 3.202 | $< 2x10^{-16}$ |
| **Ln Systolic BP (mm Hg)** | 2.531 | $1.1x10^{-14}$ | 1.535 | $5.3x10^{-8}$ |
| **Ln BMI ($kg/m^2$)** | 1.553 | $4.4x10^{-10}$ | -0.193 | 0.39 |
| **Ln total cholesterol (mg/dL)** | 0.223 | 0.34 | -0.060 | 0.77 |
| **Ln HDL cholesterol (mg/dL)** | -0.457 | 0.0046 | -0.279 | 0.043 |
| **Current smoker (1=Yes, 0=No)** | 0.942 | $< 2x10^{-16}$ | 0.931 | $< 2x10^{-16}$ |
| **Diabetes (1=Yes, 0=No)** | 0.703 | $7.8x10^{-8}$ | 0.755 | $1.3x10^{-8}$ |
| **Antihypertension treatment (1=Yes, 0=No)** | 0.304 | 0.0023 | 0.250 | 0.0069 |
| **C Statistic (SE)** | 0.82 (0.013) | | 0.74 (0.01) | |

## Online Figures

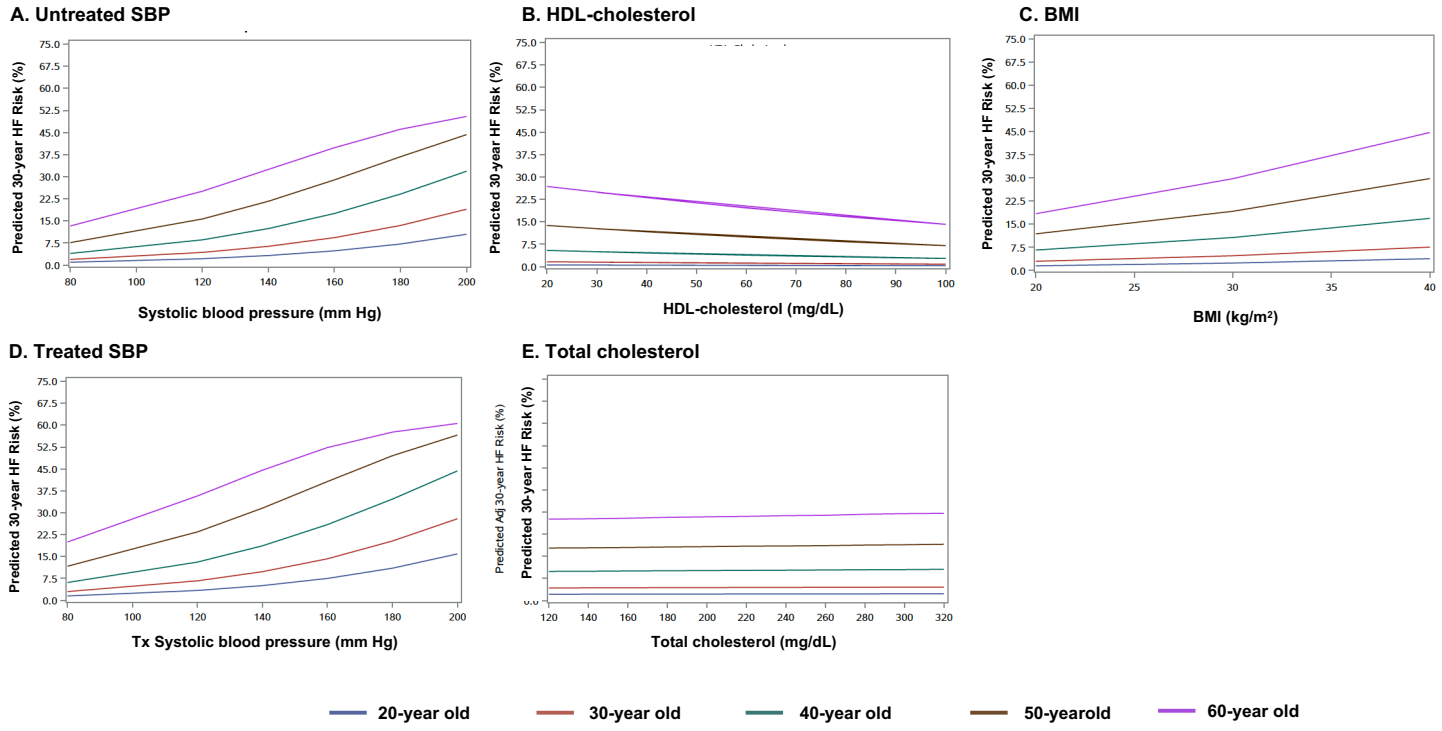
### Online Figure I. Predicted 30-year Risk of HF for a Non-Hispanic white man at different age groups with varying risk factor levels adjusted for competing risk of non-HF death



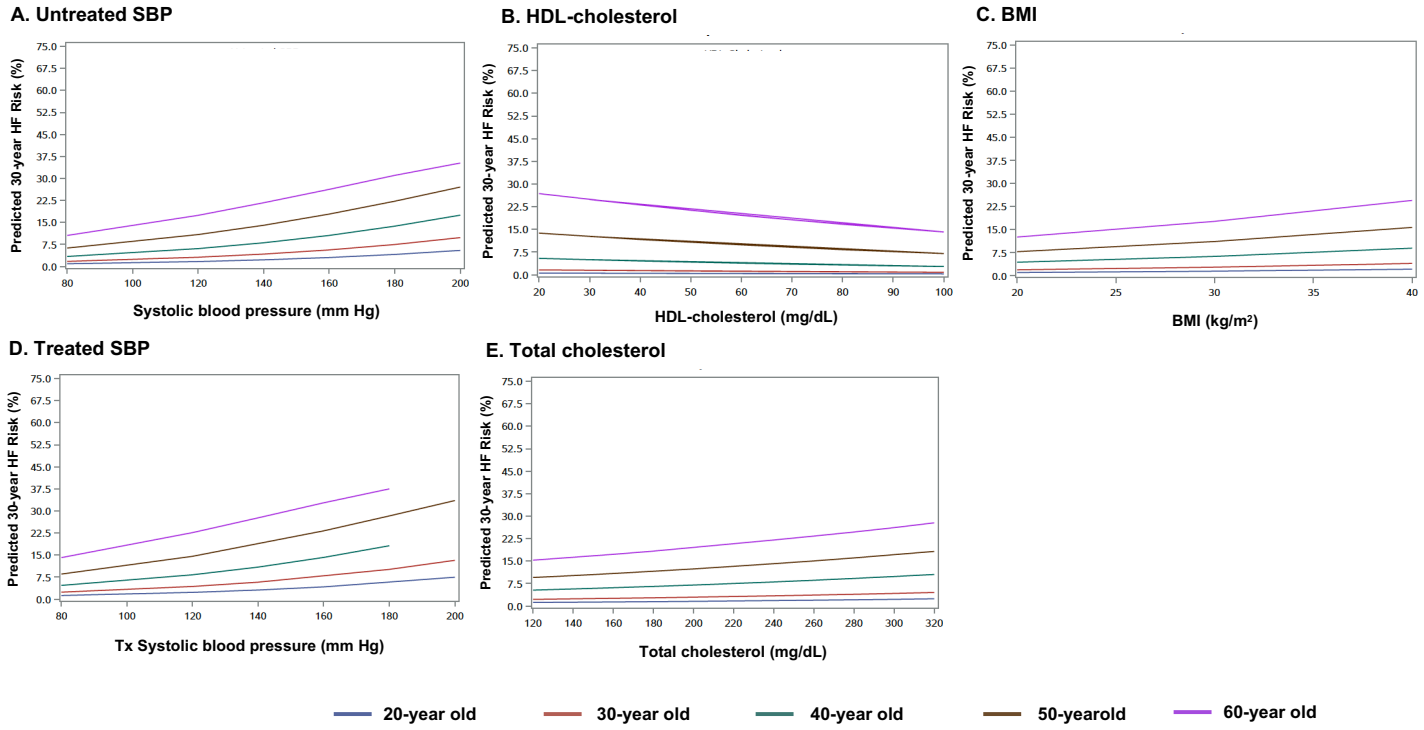
**Online Figure II. Predicted 30-year Risk of HF for a Non-Hispanic white woman at different age groups with varying risk factor levels adjusted for competing risk of non-HF death**



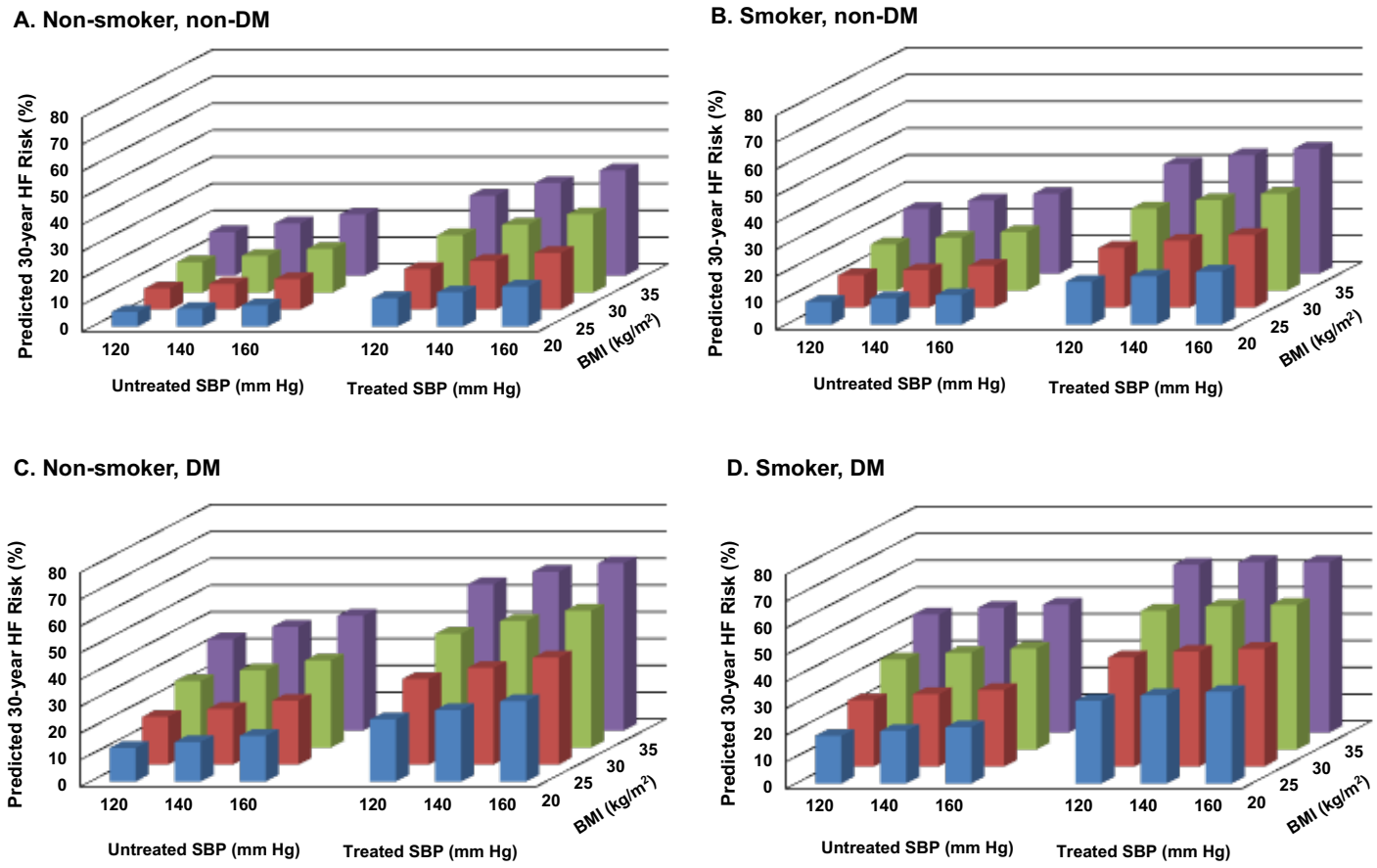
**Online Figure III. Predicted 30-year Risk of HF for a Non-Hispanic Black man at different age groups with varying risk factor levels adjusted for competing risk of non-HF death**



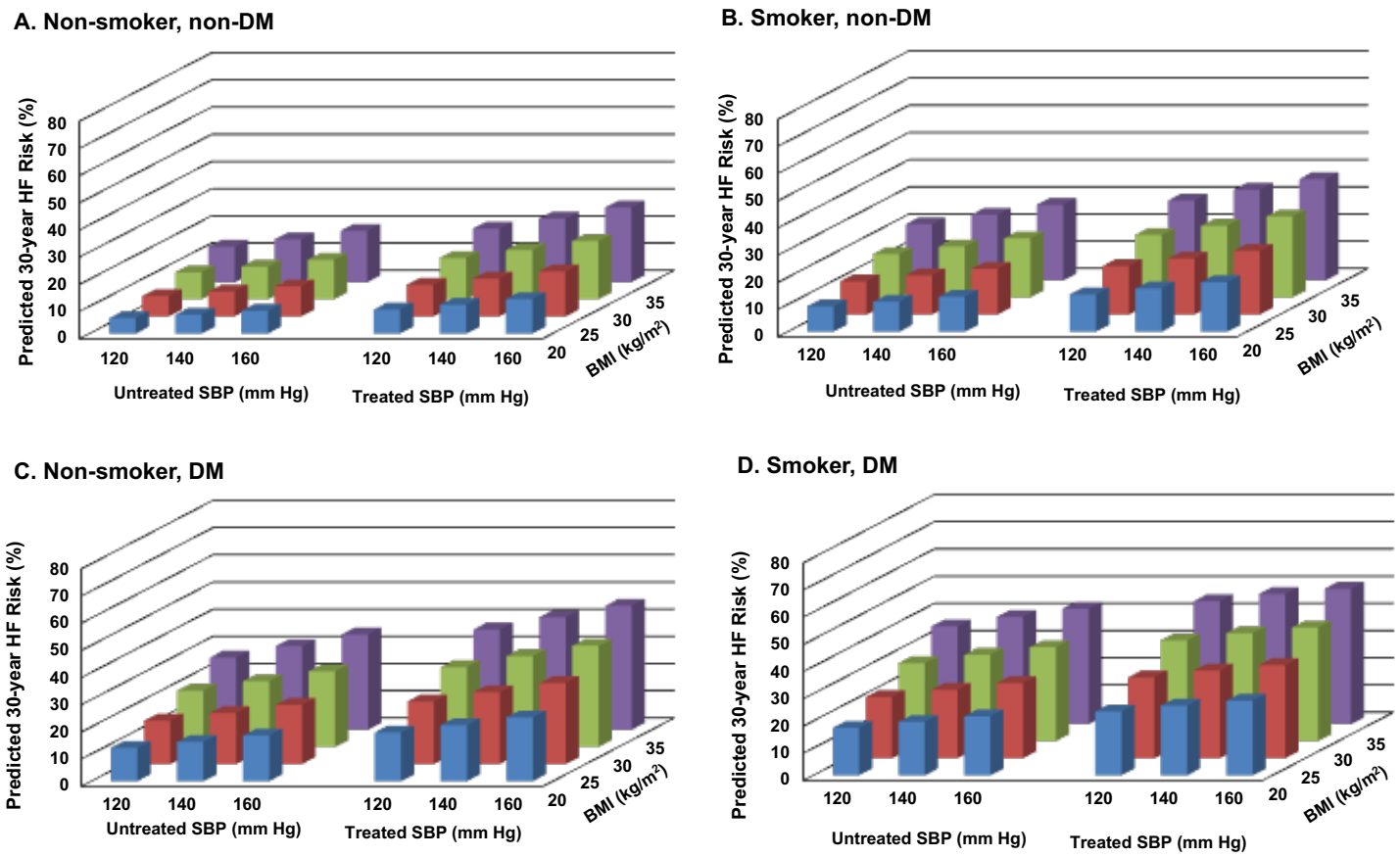
**Online Figure IV. Predicted 30-year Risk of HF for a Non-Hispanic Black woman at different age groups with varying risk factor levels adjusted for competing risk of non-HF death**



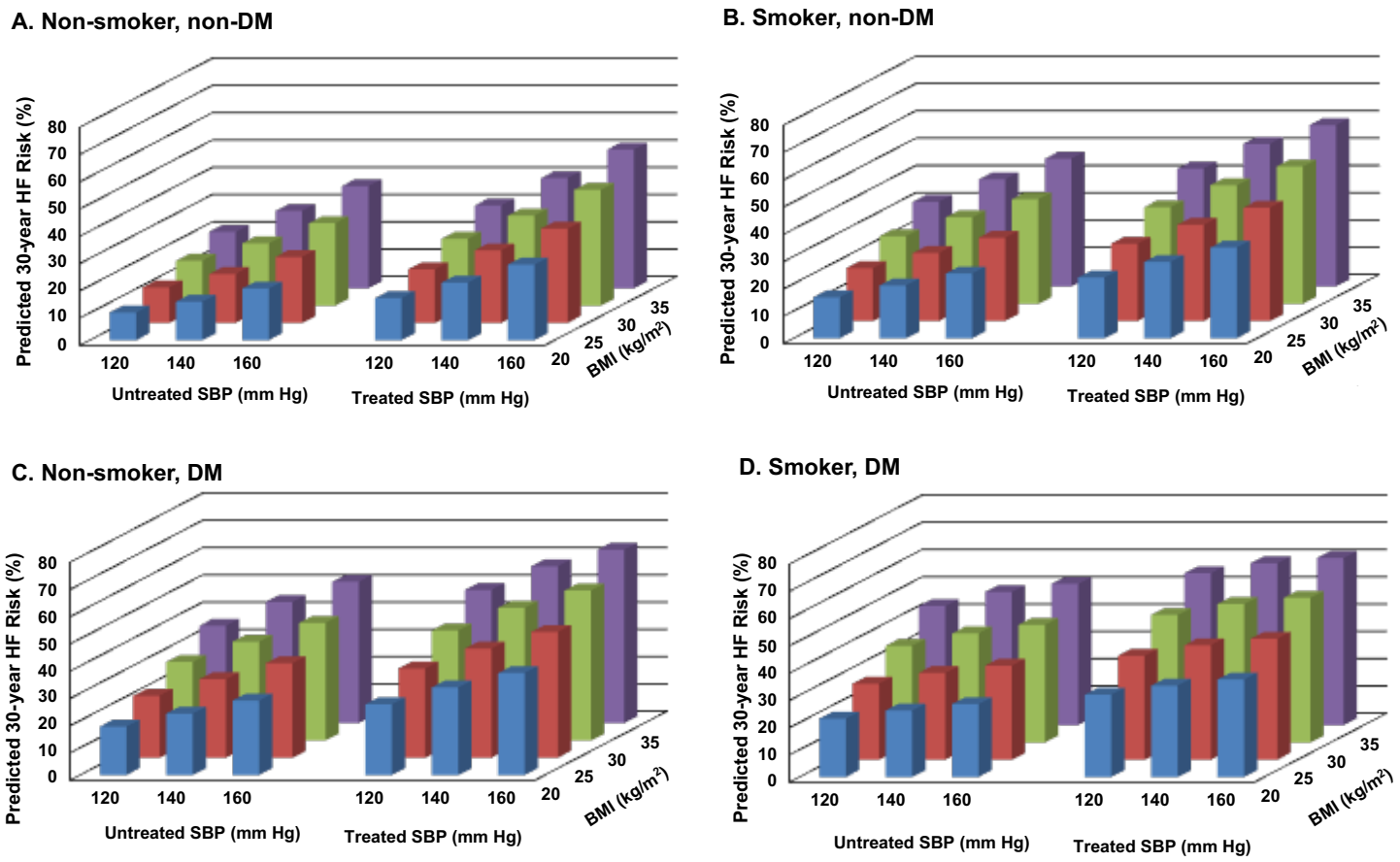
**Online Figure V. Predicted 30-year risk of HF for a hypothetical 40-year white man varying multiple risk factors adjusted for competing risk of non-HF death**



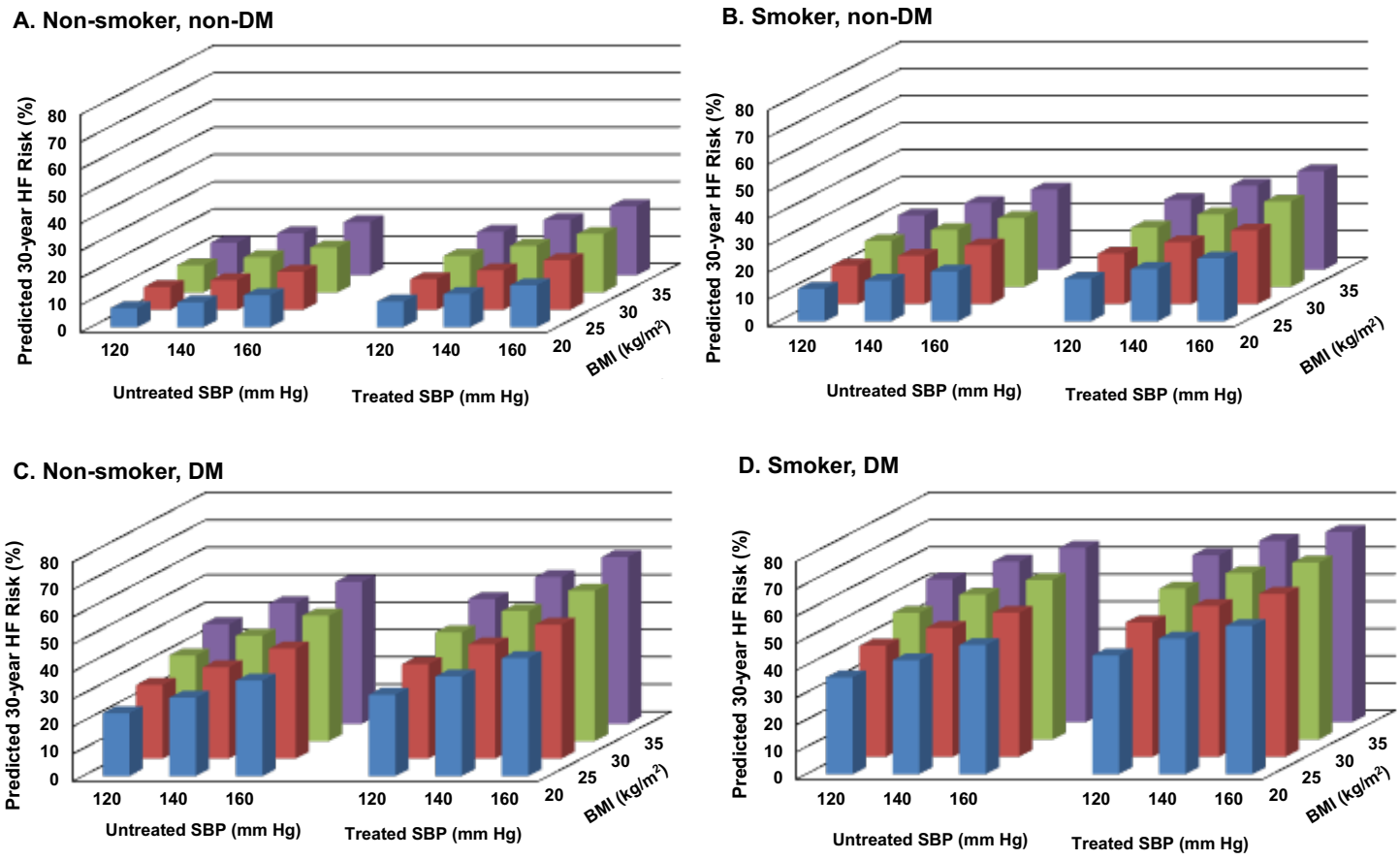
**Online Figure VI. Predicted 30-year risk of HF for a hypothetical 40-year old white woman varying multiple risk factors adjusted for competing risk of non-HF death**



**Online Figure VII. Predicted 30-year risk of HF for a hypothetical 40-year old Black man varying multiple risk factors adjusted for competing risk of non-HF death**



**Online Figure VIII. Predicted 30-year risk of HF for a hypothetical 40-year old Black woman varying multiple risk factors adjusted for competing risk of non-HF death**



## Expanded Methods

### I. Cohort Descriptions and Outcome Ascertainment

Framingham Heart Study and Framingham Offspring Study

The Framingham Heart Study and Framingham Offspring cohort recruited participants in 1971 and detailed methods have been previously published.[20] Briefly, participants have been followed with physical examinations and blood tests every 2 to 4 years. At each visit, HF events were identified, all hospital records reviewed, and diagnosis of HF confirmed by a panel of three physicians.[20] After excluding individuals due to prevalent CVD or HF, age < 30 years, and due to missing covariates, 1881 individuals were included in the derivation cohort and 1892 were included in the internal validation cohort.

Multi-Ethnic Study of Atherosclerosis (MESA)

The MESA cohort recruited asymptomatic participants ages 45 to 84 years from six US communities between 2000-2002, and included white, Black, Hispanic, and Asian individuals with detailed methods previously described.[18]. All participants were contacted by telephone every 6 to 9 months to inquire about interim hospitalizations and medical records were obtained. HF events were adjudicated by two physicians after review of all available study visits and medical records. Any disagreements were classified by full review committee as previously published.[46] After exclusions due to age>80 and due to missing covariates, 1787 individuals were included in the derivation cohort and 1860 in the internal validation cohort.

Atherosclerosis Risk in Communities Study

The ARIC Study recruited men and women ages 45 to 64 years sampled from 4 US communities with detailed methods previously published.[17] Three methods were used for ascertainment of events: 1) participants were contacted annually by phone and records were obtained for any hospitalizations, 2) local hospitals provided lists of hospital discharges with cardiovascular diagnoses, and 3) health department death certificate files were surveyed. Incident HF was defined as the first HF hospitalization

or presence of HF code on the death certificate in any position using the *International Classification of Diseases Code, Ninth Revision (ICD-9*) code 428.x and deaths with *ICD-9/10* codes of either 428.x or I50. After excluding individuals due to prevalent CVD or HF and due to missing covariates, 5059 individuals were included in the derivation cohort and 5132 were included in the internal validation cohort.

Coronary Artery Risk Development in Young Adults Study

The CARDIA study recruited 5115 Blacks and whites in 1985-1986 from Birmingham, Alabama; Chicago; Minneapolis; and Oakland, California with full details previously described.[19] All participants were contacted annually by telephone and during scheduled study examinations to report interim hospitalizations. Two members of the endpoint committee adjudicated all hospitalizations and deaths with disagreements resolved by consensus. Hospitalization for heart failure required both that a final diagnosis of heart failure had been made by a physician and that medical treatment for heart failure had been administered during the hospitalization. Death was considered to be due to heart failure if the adjudicated cause was cardiovascular and if an *International Classification of Diseases, Ninth Revision* (ICD-9) code for heart failure (428) or cardiomyopathy (425) was noted as a contributory cause. Deaths were reported to the field centers every 6 months, and records were requested after consent had been obtained from the next of kin. After excluding participants with age<30 and due to missing covariates, 1805 individuals were included in the derivation cohort and 1706 individuals were included in the internal validation cohort.

## II. Methods and Statistical Analysis for Long-Term Risk Estimation

To predict cumulative incidence rates for HF events and non-HF death, two Cox regression models for cause-specific risk of HF events and non-HF death were fitted to the data.[23] The baseline cumulative hazard function and regression coefficients were estimated, which were then used to estimate the lifetime HF risk. Specifically, the cause-specific hazard function for HF events and non-HF death for participants with predictor Z and age s were displayed as follows:

$$\lambda_{HF}(t|Z, age = s) = \lambda_1(t,s)e^{\beta(s)'Z} \text{ and } \lambda_{DTH}(t|Z, age = s) = \lambda_2(t,s)e^{\gamma(s)'Z}$$

The cumulative HF incidence rate as a function of age t for a participant having predictor Z measured at age s can be expressed as:

$$e^{\beta(s)'z}\int_0^t \exp\{-\Lambda_{HF}(u,s)e^{\beta(s)'z} - \Lambda_{DTH}(u,s)e^{\gamma(s)'z}\}d\Lambda_{HF}(u,s)$$

Where

$\Lambda_{HF}(u,s) = \int_0^u \lambda_{HF}(v,s)dv$ and $\Lambda_{DTH}(u,s) = \int_0^u \lambda_{DTH}(v,s)dv$

With observed data, one may replace all the model parameters by their estimators. To this end, we assume that the dataset consists of *n* observations with the same baseline age *s,*

$$(Y_i, \delta_{HF_i}, \delta_{DTHi}, Z_i), i = 1, \cdots, n.$$

First, by maximizing the partial likelihood function, one may obtain the estimate $\beta(s)$ and $\gamma(s)$ denoted $\hat{\beta}(s)$ $\hat{\gamma}(s)$, respectively. One then may estimate, the risk of HF and, the competing risk of death by the Breslow estimators:

$$\widehat{\Lambda}_{HF}(u,s) = \sum_{i=1}^{n} \frac{I(Y_i \le u)\delta_{HF_i}}{\sum_j I(Y_j \ge Y_i)e^{\hat{\gamma}(s)'Z_j}} \text{ and } \widehat{\Lambda}_{DTH}(u,s) = \sum_{i=1}^{n} \frac{I(Y_i \le u)\delta_{DTHi}}{\sum_j I(Y_j \ge Y_i)e^{\hat{\gamma}(s)'Z_j}}$$

In this context, the predictor Z is a vector consisting of individual risk factors including blood pressure, body mass index, total cholesterol, HDL-cholesterol, and smoking, diabetes, and hypertensive therapy status.

**III. Long-term Risk Prediction Model Performance**

We internally validated model performance using 10-fold cross-validation. Using this approach, the original study sample was randomly split into 10 distinct blocks roughly equal in size. We left out the first block (the test set), and fit the model using the remaining 9 blocks of sample (the training set) to predict the randomly held–out sample. This process was repeated 10 times until the model predicted all 10 randomly held-out-samples. Discrimination was estimated with Harrell's c statistics for each of the 10 validation attempts and the mean and 95% confidence interval of c statistics across the 10 repetitions was reported. Calibration of model examining differences between predicted and observed risk estimates adjusted for the competing risk of non-heart failure death were plotted across the 10 repetitions, and the overall Hosmer-Lemeshow calibration $\chi 2$ was assessed. Model performance of the PCP-HF tool was then evaluated using the Harrell C statistics with less than 0.70, 0.70 to 0.80, and greater than 0.80 defined a priori based on prior publications as inadequate, acceptable, and excellent discrimination levels, respectively.[24] Model calibration was evaluated by the GND approach with adequate calibration defined a priori as $X^2<20$.[24]

**D. Systematic Examination: Variation of Single and Multiple Risk Factors**

First, we held all risk factors constant at the age–adjusted national mean levels for each sex-race and age group for hypothetical individuals of all age spectrum of 20 to 59 years, to estimate the effect of age on 30-year HF risk. Non-smoking and nondiabetic status was taken as the normative values for the population. The risk estimates were calculated separately for those with and without antihypertensive therapy. Next, we varied each individual risk factor while holding the other risk factor levels constant at age-adjusted national mean values in order to compare the effects of single risk factors on 30-year predicted HF risk in all sex and race subgroups. Again, we used non-smoking and nondiabetic status. We varied levels of individual risk factors as follows: SBP from 80 to 200 mmHg in intervals of 20 mmHg; BMI from 20 to 40 kg/m$^2$ in intervals of 5 kg/m$^2$; Total cholesterol from 120 to 320 mg/dl in

increments of 20mg/dl; and HDL-cholesterol from 20 to 100 mg/dl in intervals of 10 mg/dl. These ranges were selected based on clinically relevant values that were included in the derivation cohort, given the known limitations with extreme outliers of risk factor levels. We also calculated distinct 30-year predicted HF risk estimates with and without antihypertensive therapy, holding all other risk factors constant at age-adjusted national mean values derived for non-smoking, non-DM US adults for each sex-race and age group. For example, to determine the effect of BMI on 30-year predicted HF risk in a 40-year old Black man, we set untreated SBP to 129 mm Hg, TC to 191 mg/dL, and HDL-C to 53 mg/dL, selected non-smoking status, and varied BMI from 20 to 40 $kg/m^2$. For all analyses, we calculated 30-year predicted HF risk for each sex-race and age group.

Finally, we examined the influence of combinations of risk factors on 30-year predicted HF risk by varying risk factor levels systematically across the range of clinical variables. We chose ranges and intervals approximating 1 standard deviation in the population of US adults of SBP and BMI. For SBP, values with or without antihypertensive treatment that were included were 120 mm Hg, 140 mm Hg, and 160 mm Hg. For BMI, values included were 20 $kg/m^2$, 25 $kg/m^2$, 30 $kg/m^2$, and 35 $kg/m^2$. We varied the categorical variables of smoking status, diagnosis of DM, and antihypertensive therapy for all risk factor combinations. We examined ages for several intervals but only display results of each sex and race subgroup at 40 years old. We chose this age given that incidence of HF is extremely low prior to this age and estimation of 30-year risk would capture a large proportion of residual lifetime risk. Therefore, we judged that it would offer the most relevant risk factor combinations in a theoretical at-risk patient, understanding that the absolute 30-year HF risk estimation varies significantly with age. Additional details are available in the R function that users can access in addition to the help file provided to enhance translatability of this risk prediction tool for long-term estimation of HF risk.

**User Instructions for R Function**

In this section, we demonstrate how to estimate the predicted 30 years risk of heart failure using our sex- and race-specific HF risk equations, including age, SBP, BMI, total cholesterol, high density lipoprotein cholesterol, smoking, diabetes, and hypertension treatment status. The long-term HF risk prediction model was developed among 5 population-based cohorts using case-specific hazard model to account for competing risk as described in the paper.

R > load('your directiory/cvdcmprsk.RData')

In the next step, you input the individual record for which you want to predict as vector riskfactors. The input of sex and race is "male" or "female", and "white" or "black".

R > riskfactors =c(age, sbp, bmi, tc, hdl, smoking, diabetes, hypertension treatment)

R > fit=lifecvd (sex, race, riskfactors)

Smoking, diabetes, and hypertension treatment are all binary values (1/0)

SBP value is ranged from 80 to 200 mm Hg; TC is ranged from 100 to 300 mg/dL; HDL is ranged from 30 to 100 mg/dL.

Finally, you can plot the cumulative incidence curve for HF and its competing risk

time=fit$time

incidence1=fit$incidence1

upper1=fit$CI1[,2]

lower1=fit$CI1[,1]

incidence2=fit$incidence2

upper2=fit$CI2[,2]

lower2=fit$CI2[,1]

```
UL1=upper1
LL1=lower1
UL2=upper2
LL2=lower2
result=data.frame(cbind(time, incidence1, UL1, LL1, incidence2,UL2, LL2))
par(mfrow=c(1, 2))
plot(result$time , result$incidence1,  ylab  = "cumulative risk", xlab="Years",ylim=c(0,1),xlim=c(0,30),
    main = "Predicted cumulative risk for HF", cex.main=1)
lines(result$time, result$UL1, lwd=1)
lines(result$time, result$LL1, lwd=1)
plot(result$time , result$incidence2,ylim=c(0,1),xlim=c(0,30),
    ylab  = "cumulative risk%", xlab="Years",
    main = "Predicted cumulative risk for death", cex.main=1, )
lines(result$time, result$incidence2, type ='l', lwd=1)
lines(result$time, result$UL2, lwd=1)
lines(result$time, result$LL2, lwd=1)
```

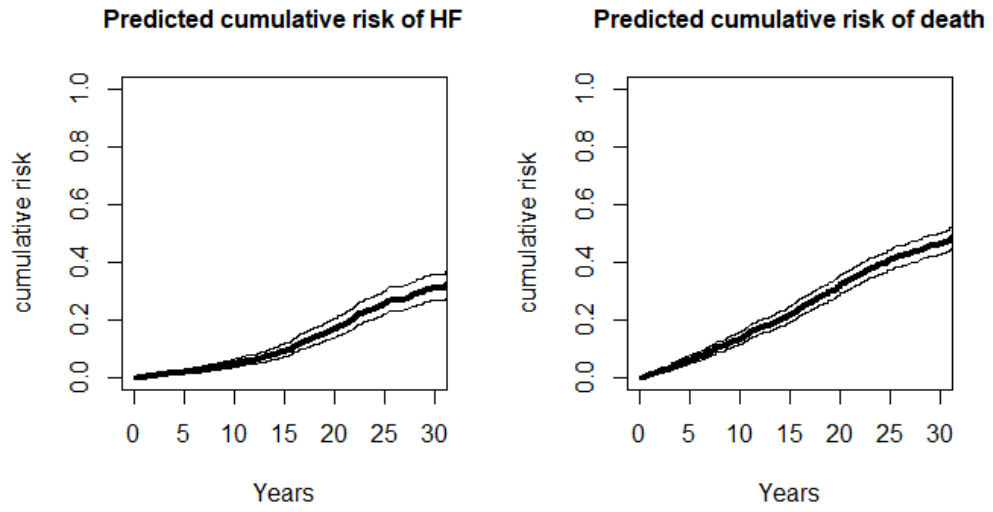
**Example 1:** A Black man who 55 years of age, with sbp of 120 mmHg, BMI of 26.8kg/m2, total cholesterol of 213 mg/dL, HDL-c of 50 mg/dL, nonsmoker, diabetes, no bp treatment

R > load('**your directory**/ cvdcmprsk.RData')

R > RF=c(55, 120, 26.8, 213, 50, 0, 1, 0)

R > fit=lifecvd(sex="male",  race="black", riskfactors=RF)

This will enable users to create figures of predicted cumulative risk over time using the R code for plotting




**Example 2:** A White woman who is 55 years of age, with sbp of 120 mmHg, BMI of 26.8kg/m2, total cholesterol of 325 mg/dL, HDL-c of 25 mg/dL, nosmoker, diabetic, no bp treatment

R > load('**your directory**/ cvdcmprsk.RData')

R > RF = c(55, 120, 26.8, 325, 25, 0, 1, 0)

R > fit=lifecvd(sex="female", race="white", riskfactors=RF)

You will obtain the following message:

1] "TC has to be within 100 and 320 mg/dL"

[1] "HDL has to be within 30 and 100 mg/dL"

**Major Resources Table**

In order to allow validation and replication of experiments, all essential research materials listed in the Methods should be included in the Major Resources Table below. Authors are encouraged to use public repositories for protocols, data, code, and other materials and provide persistent identifiers and/or links to repositories when available. Authors may add or delete rows as needed.

**Animals (in vivo studies)**

N/A

**Genetically Modified Animals**

N/A

**Antibodies**

N/A

**DNA/cDNA Clones**

N/A

**Cultured Cells**

N/A

**Data & Code Availability**

| Description | Source / Repository | Persistent ID / URL |
|---|---|---|
| Individual-level participant data on risk factor levels and outcomes | National Heart, Lung, and Blood Institute | https://biolincc.nhlbi.nih.gov/home/ |

| | | |
|---|---|---|
| | Biologic Specimen and Data Repository Information Coordinating Center (BioLINCC) | |

**Other**

N/A