SUPPLEMENTAL MATERIAL

Data S1. Supplemental Methods

Study Population

The Tehran Lipid and Glucose Study (TLGS) is a prospective cohort study was first designed in 1997 and implemented in 1999 in a west-Asian developing country, the Islamic republic of Iran (23). The protocol of the TLGS was based on the WHO-recommended model for field surveys of diabetes and other non-communicable diseases (NCDs) and the WHO-MONICA protocol (25) for population surveys (27). The main goal of the TLGS was understanding the risk factors and outcomes of NCDs in a representative sample of residents of Tehran, capital of Iran. Tehran city covers an area of 1500 km^2 and consists of 22 districts with a total population of over ten million people. In 1999, Tehran was composed of 20 urban districts and made up a population of 6.7 million. Study samples were chosen from the urban District 13 of Tehran, because city-wide data showed a high rate of stability in that district. Also, the age distribution in district 13 was representative of the overall population in Tehran (26). This district is under the coverage of Shahid Beheshti University of Medical Sciences and Health Services and have 20 medical health centers. All medical health centers in this district have the filed data of almost all covered families (over 90%) (24). TLGS consists of several phases, the phase 1 (1999-2001) was a cross-sectional, in which from the 20 medical health centers in district 13, three health centers of Lailatolghadr, Mohammadian, and Salavati were selected. Then, a multi-stage stratified cluster random sampling technique was used to select study sample. The selected subjects were contacted, invited, and then recruited to participate in the study and were referred to one of the three chosen medical health centers for the measurements. More than 15000 people aged $\geq$ 3 years participated in phase 1, with crude response rate of about 57.5%. However, preliminary data revealed there was no significant different between responders and non-responders. Following baseline collection of data in phase 1, the prospective follow up studies were conducted in phases 2 (2002-2005), 3 (2005-2008), 4 (2009-2011), 5 (2012-2015), and 6 (2015-2018) by means of about 3 years intervals

between assessments. Moreover, during the phases 2, about 3550 new participants were recruited and were followed in next phases.

In all phases, participants, after signing informed written consent, were studied by trained social workers and physicians according to a uniform protocol. Demographic, lifestyle information, medical history and clinical examination were obtained by the use of a standard and validated questionnaire. Blood pressure, and anthropometrical measurements were taken according to the standard protocol. For biochemical measurements, a blood sample was drawn between 7:00 and 9:00 AM into vacutainer tubes from all study participants after 12-14 hours overnight fasting. All laboratory kits were supplied by Pars Azmon Inc., Iran. Physical activity level (PAL) was assessed using Lipid Research Clinic (LRC) questionnaire in the first phase of the TLGS. Since the LRC questionnaire assesses PAL of the participant qualitatively and the questions are fully subjective, the Steering Committee of the TLGS replaced the questionnaire by Modifiable Activity Questionnaire (MAQ) and a Persian translated form of that was used to assess PAL in the TLGS participants. This questionnaire measures all three forms of activities including leisure time, job, and household activities in the past year (31).

For the present study, 9014 participants aged 20-50 years from the first (n=7133) and second (n=1881) phases were selected and followed until the end of the study (18 April 2018). We excluded 908 individuals with prevalent hypertension at baseline, 245 people who had missing data on hypertension status at baseline, and 1430 individuals with no follow-up data after recruitment. Because at least three measurements of metabolic risk factors (MRFs) were required for studying trajectory of MRFs, we further excluded 1057 people who did not participate at least two times before hypertension incidence or before the last participation for those who did not develop hypertension. Finally, 5374 adults (2191 men) formed the study population (Figure S1). At baseline, less than 5% of study population had missing values for several MRFs and other covariates; thus, we chose not to exclude these individuals. The

study populations were participated 3-6 times during the study period (5 times on average). The number of participants who were participated 3, 4, 5 and 6 times was 662, 872, 1667 and 2173, respectively. It should be noted that some individuals had also missing values in MRFs in a number of follow-up examinations. Therefore, the number of participations may not be necessarily equal to the number of measurements. This case's missing values are unproblematic; because, the person-period data set does not include records for these unobserved phases in longitudinal analysis (29). Second, <5% of MRFs values were missing in person-period format. In Table S1, we have presented the detailed information about dataset. This study was approved by the ethical committee of the Research Institute for Endocrine Sciences of Shahid Beheshti University of Medical Sciences, Tehran, Iran. All participants provided written informed consent.

Table S1. Information about data in person-period format, 1999-2018.

Variable	Men		Women	
	Number of observations	Number of excluded records (%)	Number of observations	Number of excluded records (%)
Age	10115	0 (0)	15355	0 (0)
BMI	9906	209(2)	14834	521 (3)
WC	9904	211(2)	14799	556 (4)
FPG	9936	179(2)	15184	171 (1)
SBP	9973	142(1)	15206	149 (1)
DBP	9973	142(1)	15206	149 (1)
HDL-C	9933	182(2)	15178	177 (1)
Ln-TG	9938	177(2)	15186	169 (1)
TC	9941	174(2)	15185	170 (1)

In the person-period dataset, each person has multiple records according to the number of participation in the study; for example, if a man had participated 4 times in the study, he had 4 records in the dataset. Therefore, if he had missing value for one of the variables in one examination, that record was excluded, and three other records remained for the longitudinal analysis.

BMI: body mass index; WC: waist circumference; **FPG:** fasting plasma glucose; **SBP:** systolic blood pressure, **DBP:** diastolic blood pressure; **HDL-C:** high-density lipoprotein cholesterol; **Ln-TG:** natural log of triglyceride; **TC:** total cholesterol; **SD:** standard deviation

Table S2. Characteristics of final growth models for metabolic risk factors in men.

	Type of model	Models	Residual heteroscedasticity	Residual correlation structure
BMI (kg/m^2)	Cubic growth model with the intercept and slopes variability	Level 1: $BMI_{ij} = b_{oi} + b_1Age_{ij} + b_2Age^2_{ij} + b_3Age^3_{ij} + e_{ij}$ Level 2: $b_{oi} = \beta_0 + u_{0i}$ Level 2: $b_{1i} = \beta_1 + u_{1i}$ Level 2: $b_{2i} = \beta_2 + u_{2i}$ Level 2: $b_{3i} = \beta_3$	$\sigma^2 \times \lvert Age \rvert^{2\delta}$	First-Order Autoregressive
WC (cm)	Cubic unconditional growth model	Level 1: $WC_{ij} = b_{oi} + b_1Age_{ij} + b_2Age^2_{ij} + b_3Age^3_{ij} + e_{ij}$ Level 2: $b_{oi} = \beta_0 + u_{0i}$ Level 2: $b_{1i} = \beta_1$ Level 2: $b_{2i} = \beta_2$ Level 2: $b_{3i} = \beta_3$	$\sigma^2 \times e^{2\delta \times Age}$	First-Order Autoregressive
FPG (mmol/L)	Cubic growth model with the intercept and slope variability	Level 1: $FPG_{ij} = b_{oi} + b_1Age_{ij} + b_2Age^2_{ij} + b_3Age^3_{ij} + e_{ij}$ Level 2: $b_{oi} = \beta_0 + u_{0i}$ Level 2: $b_{1i} = \beta_1 + u_{1i}$ Level 2: $b_{2i} = \beta_2$ Level 2: $b_{3i} = \beta_3$	$\sigma^2 \times e^{2\delta \times Age}$	First-Order Autoregressive
SBP (mmHg)	Quadratic growth model with the int ercept and slope v ariability	Level 1: $SBP_{ij} = b_{oi} + b_1Age_{ij} + b_2Age^2_{ij} + e_{ij}$ Level 2: $b_{oi} = \beta_0 + u_{0i}$ Level 2: $b_{1i} = \beta_1 + u_{1i}$ Level 2: $b_{2i} = \beta_2$	$\sigma^2 \times \lvert Age \rvert^{2\delta}$	First-Order Autoregressive
DBP (mmHg)	Cubic unconditional growth model	Level 1: $DBP_{ij} = b_{oi} + b_1Age_{ij} + b_2Age^2_{ij} + b_3Age^3_{ij} + e_{ij}$ Level 2: $b_{oi} = \beta_0 + u_{0i}$ Level 2: $b_{1i} = \beta_1$ Level 2: $b_{2i} = \beta_2$ Level 2: $b_{3i} = \beta_3$	$\sigma^2 \times e^{2\delta \times Age}$	First-Order Autoregressive
HDL-C (mmol/L)	Cubic growth model with the intercept and slopes variability	Level 1: $HDL_{ij} = b_{oi} + b_1Age_{ij} + b_2Age^2_{ij} + b_3Age^3_{ij} + e_{ij}$ Level 2: $b_{oi} = \beta_0 + u_{0i}$ Level 2: $b_{1i} = \beta_1 + u_{1i}$ Level 2: $b_{2i} = \beta_2 + u_{2i}$ Level 2: $b_{3i} = \beta_3$	-	-
Ln-TG (mmol/L)	Quadratic growth model with the intercept and slope variability	Level 1: $Ln\text{-}TG_{ij} = b_{oi} + b_1Age_{ij} + b_2Age^2_{ij} + b_3Age^3_{ij} + e_{ij}$ Level 2: $b_{oi} = \beta_0 + u_{0i}$ Level 2: $b_{1i} = \beta_1 + u_{1i}$ Level 2: $b_{2i} = \beta_2 + u_{2i}$ Level 2: $b_{3i} = \beta_3$	$\sigma^2 \times e^{2\delta \times Age}$	First-Order Autoregressive
TC (mmol/L)	Quadratic growth model with the intercept and slope variability	Level 1: $TC_{ij} = b_{oi} + b_1Age_{ij} + b_2Age^2_{ij} + e_{ij}$ Level 2: $b_{oi} = \beta_0 + u_{0i}$ Level 2: $b_{1i} = \beta_1 + u_{1i}$ Level 2: $b_{2i} = \beta_2$	-	First-Order Autoregressive

$\sigma^2 \times |Age|^{2\delta}$: Variance proportional to the absolute value of Age raised to a constant power

$\sigma^2 \times e^{2\delta \times Age}$: variance proportional to the exponential of Age multiplied by a constant

BMI: body mass index; WC: waist circumference; **FPG:** fasting plasma glucose; **SBP:** systolic blood pressure, **DBP:** diastolic blood pressure; **HDL-C:** high-density lipoprotein cholesterol; **Ln-TG:** natural log of triglyceride; **TC:** total cholesterol.

Table S3. Characteristics of final growth models for metabolic risk factors in women.

	Type of model	Models	Residual heteroscedasticity	Residual correlation structure
BMI (kg/m^2)	Quadratic unconditional growth model	Level 1: $BMI_{ij} = b_{oi} + b_1 Age_{ij} + b_2 Age^2_{ij} + e_{ij}$ Level 2: $b_{oi} = \beta_0 + u_{0i}$ Level 2: $b_{1i} = \beta_1$ Level 2: $b_{2i} = \beta_2$	$\sigma^2 \times e^{2\delta \times Age}$	First-Order Autoregressive
WC (cm)	Quadratic conditional growth model	Level 1: $WC_{ij} = b_{oi} + b_1 Age_{ij} + b_2 Age^2_{ij} + e_{ij}$ Level 2: $b_{oi} = \beta_0 + u_{0i}$ Level 2: $b_{1i} = \beta_1 + u_{1i}$ Level 2: $b_{2i} = \beta_2$	$\sigma^2 \times e^{2\delta \times Age}$	First-Order Autoregressive
FPG (mmol/L)	Cubic growth model with the intercept and slope variability	Level 1: $FPG_{ij} = b_{oi} + b_1 Age_{ij} + b_2 Age^2_{ij} + b_3 Age^3_{ij} + e_{ij}$ Level 2: $b_{oi} = \beta_0 + u_{0i}$ Level 2: $b_{1i} = \beta_1 + u_{1i}$ Level 2: $b_{2i} = \beta_2$ Level 2: $b_{3i} = \beta_3$	$\sigma^2 \times e^{2\delta \times Age}$	First-Order Autoregressive
SBP (mmHg)	Quadratic growth model with the intercept and slope variability	Level 1: $SBP_{ij} = b_{oi} + b_1 Age_{ij} + b_2 Age^2_{ij} + e_{ij}$ Level 2: $b_{oi} = \beta_0 + u_{0i}$ Level 2: $b_{1i} = \beta_1 + u_{1i}$ Level 2: $b_{2i} = \beta_2 + u_{2i}$	Was not adjusted fo r variance structure	Compound Symmetry
DBP (mmHg)	Cubic growth model with the intercept and slope variability	Level 1: $DBP_{ij} = b_{oi} + b_1 Age_{ij} + b_2 Age^2_{ij} + b_3 Age^3_{ij} + e_{ij}$ Level 2: $b_{oi} = \beta_0 + u_{0i}$ Level 2: $b_{1i} = \beta_1 + u_{1i}$ Level 2: $b_{2i} = \beta_2$ Level 2: $b_{3i} = \beta_3$	-	-
HDL-C (mmol/L)	Quadratic conditional growth model	Level 1: $HDL\text{-}C_{ij} = b_{oi} + b_1 Age_{ij} + b_2 Age^2_{ij} + b_3 Age^3_{ij} + e_{ij}$ Level 2: $b_{oi} = \beta_0 + u_{0i}$ Level 2: $b_{1i} = \beta_1 + u_{1i}$ Level 2: $b_{2i} = \beta_2$ Level 2: $b_{3i} = \beta_3$	$\sigma^2 \times e^{2\delta \times Age}$	Compound Symmetry
Ln-TG (mmol/L)	Cubic growth model with the intercept and slope variability	Level 1: $Ln\text{-}TG_{ij} = b_{oi} + b_1 Age_{ij} + b_2 Age^2_{ij} + b_3 Age^3_{ij} + e_{ij}$ Level 2: $b_{oi} = \beta_0 + u_{0i}$ Level 2: $b_{1i} = \beta_1 + u_{1i}$ Level 2: $b_{2i} = \beta_2$ Level 2: $b_{3i} = \beta_3$	$\sigma^2 \times e^{2\delta \times Age}$	First-Order Autoregressive
TC (mmol/L)	Cubic unconditional growth model	Level 1: $TC_{ij} = b_{oi} + b_1 Age_{ij} + b_2 Age^2_{ij} + b_3 Age^3_{ij} + e_{ij}$ Level 2: $b_{oi} = \beta_0 + u_{0i}$ Level 2: $b_{1i} = \beta_1$ Level 2: $b_{2i} = \beta_2$ Level 2: $b_{3i} = \beta_3$	-	First-Order Autoregressive

$\sigma^2 \times |Age|^{2\delta}$: Variance proportional to the absolute value of Age raised to a constant power

$\sigma^2 \times e^{2\delta \times Age}$: variance proportional to the exponential of Age multiplied by a constant

BMI: body mass index; WC: waist circumference; **FPG:** fasting plasma glucose; **SBP:** systolic blood pressure, **DBP:** diastolic blood pressure; **HDL-C:** high-density lipoprotein cholesterol; **Ln-TG:** natural log of triglyceride; **TC:** total cholesterol.

Table S4. Parameters of final growth models for metabolic risk factors in men.

		Intercept	Age	Age ^{2}	Age ^{3}	Variance of random intercept	Variance of random Age term	Variance of random Age^2 term
	Type of model	β_0	β_1	β_2	β_3	$\sigma^2 u_0$	$\sigma^2 u_1$	$\sigma^2 u_2$
BMI (kg/m^2)	Cubic	27.3 (0.08)	0.11 (0.004)	-0.05 (0.002)	0.002 (0.0003)	15.16 (0.49)	0.01 (0.001)	0.001 (0.0003)
WC (cm)	Cubic	94.86 (0.22)	0.51(0.01)	-0.19 (0.006)	0.007(0.0007)	89.86 (3.40)	-	-
FPG (mmol/L)	Cubic	5.35 (0.02)	0.05 (0.002)	0.005 (0.001)	-0.0005 (0.0001)	0.84 (0.03)	0.003 (0.0001)	-
SBP (mmHg)	Quadratic	111.4 (0.2)	0.22 (0.01)	0.14 (0.01)	-	61.49 (3.1)	0.10 (0.03)	-
DBP (mmHg)	Cubic	76.1 (0.1)	0.29 (0.01)	-0.038 (0.006)	-0.003 (0.001)	26.0 (1.3)	-	-
HDL-C (mmol/L)	Cubic	1.01 (0.004)	0.01 (0.0004)	0.002 (0.0001)	-0.0001 (0.00002)	0.04 (0.002)	0.00003 (0.000006)	0.000002 (0.000001)
Ln-TG (mmol/L)	Quadratic	0.56 (0.01)	0.001 (0.0006)	-0.006 (0.0003)	-	0.17 (0.006)	0.00009 (0.00002)	-
TC (mmol/L)	Quadratic	5.07 (0.01)	0.002 (0.001)	-0.011 (0.0007)	-	0.57 (0.02)	0.0005 (0.0001)	-

Values show parameter and standard error (SE).

BMI: body mass index; WC: waist circumference; **FPG:** fasting plasma glucose; **SBP:** systolic blood pressure, **DBP:** diastolic blood pressure; **HDL-C:** high-density lipoprotein cholesterol; **Ln-TG:** natural log of triglyceride; **TC:** total cholesterol

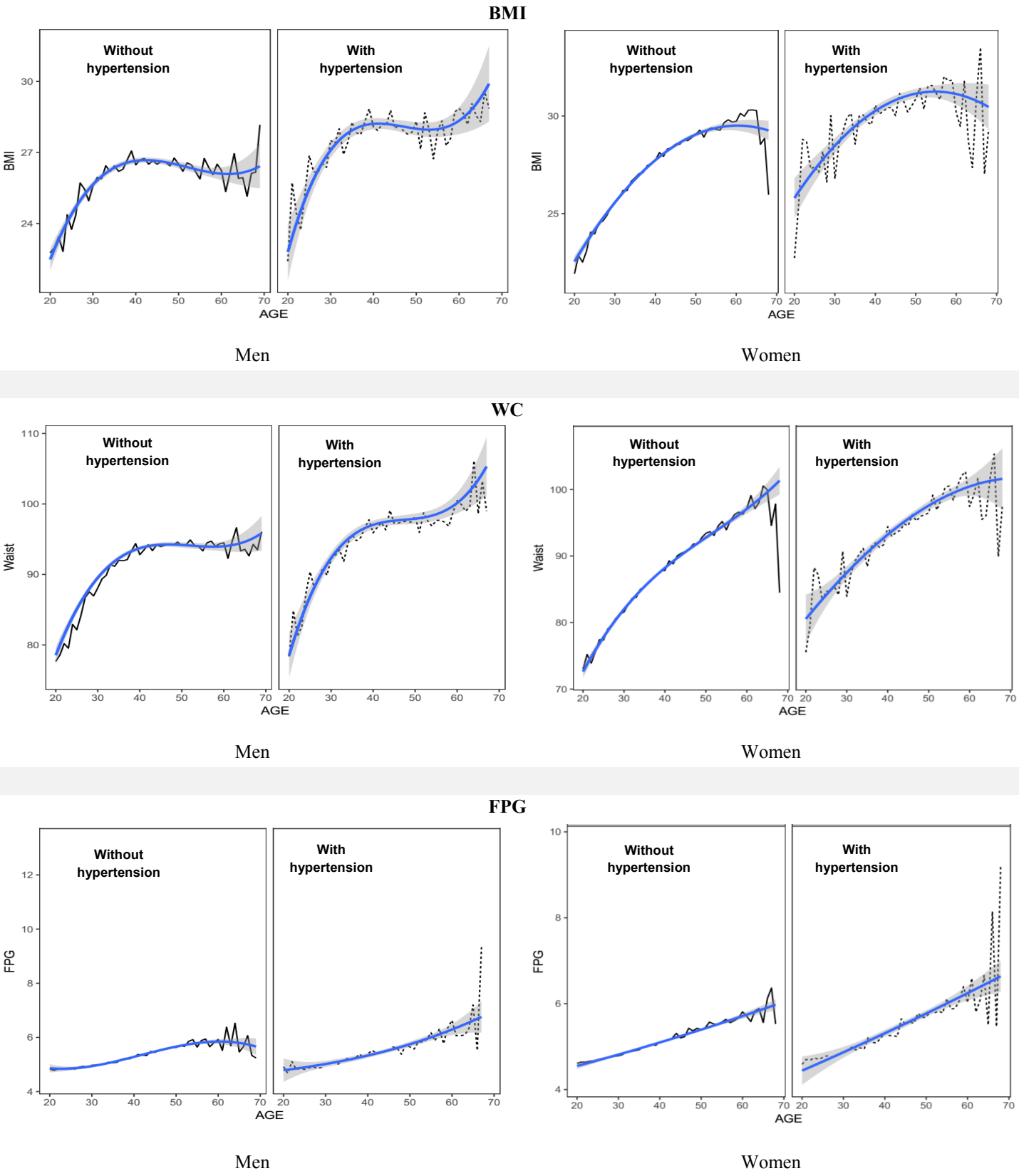
Table S5. Parameters of final growth models for metabolic risk factors in women.

		Intercept	Age	Age ^{2}	Age ^{3}	Variance of random intercept	Variance of random Age term	Variance of random Age^2 term
	Type of model	β_0	β_1	β_2	β_3	$\sigma^2 u_0$	$\sigma^2 u_1$	$\sigma^2 u_2$
BMI (kg/m^2)	Quadratic	28.45 (0.07)	0.19 (0.003)	-0.04 (0.001)	-	16.82 (0.48)	-	-
WC (cm)	Quadratic	90.11 (0.18)	0.71 (0.01)	-0.05 (0.006)	-	85.07 (2.53)	0.07 (0.009)	-
FPG (mmol/L)	Cubic	5.18 (0.02)	0.03 (0.001)	0.003 (0.0009)	-0.0002 (0.0001)	0.69 (0.02)	0.001 (0.0001)	-
SBP (mmHg)	Quadratic	107.1 (0.2)	0.33 (0.01)	0.15 (0.009)	-	78.3 (2.4)	0.14 (0.01)	0.022 (0.006)
DBP (mmHg)	Cubic	72.9 (0.12)	0.30 (0.01)	0.011 (0.005)	-0.007 (0.0008)	27.2 (1.01)	0.02 (0.005)	-
HDL-C (mmol/L)	Quadratic	1.23 (0.005)	0.012 (0.0002)	0.002 (0.0001)	-	0.07 (0.001)	0.00003 (0.000006)	-
Ln-TG (mmol/L)	Cubic	0.30 (0.01)	0.01 (0.001)	-0.002 (0.0002)	-0.0002 (0.00004)	0.14 (0.004)	0.00003 (0.00001)	-
TC (mmol/L)	Cubic	4.97 (0.01)	0.02 (0.001)	-0.001 (0.0006)	-0.0005 (0.00008)	0.44 (0.01)	-	-

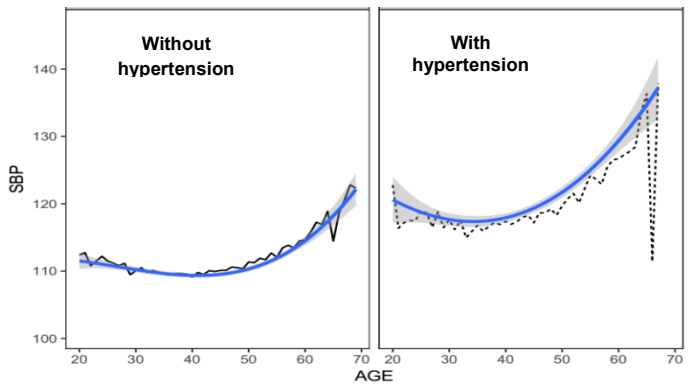
Values show parameter and standard error (SE).

BMI: body mass index; WC: waist circumference; **FPG:** fasting plasma glucose; **SBP:** systolic blood pressure, **DBP:** diastolic blood pressure; **HDL-C:** high-density lipoprotein cholesterol; **Ln-TG:** natural log of triglyceride; **TC:** total cholesterol

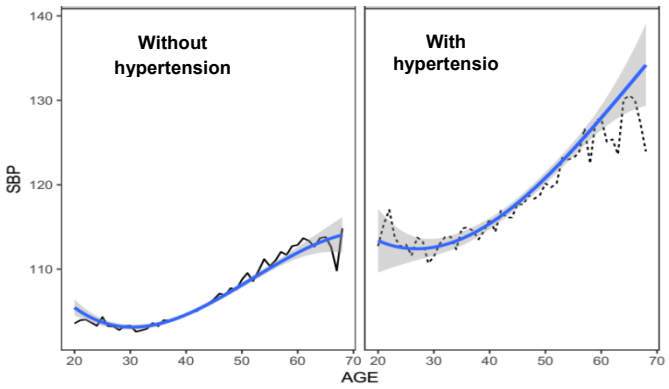
Figure S1. Mean of predicted value for metabolic risk factors from the final models for men and women.



SBP

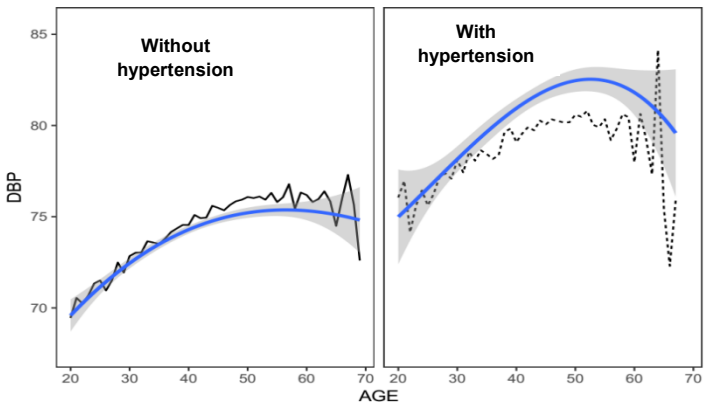


Men

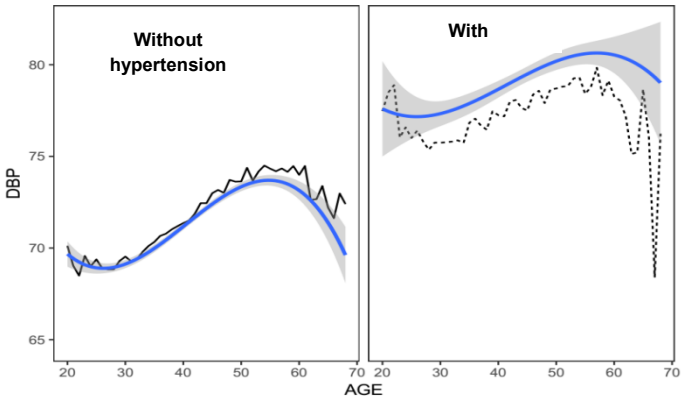


Women

DBP

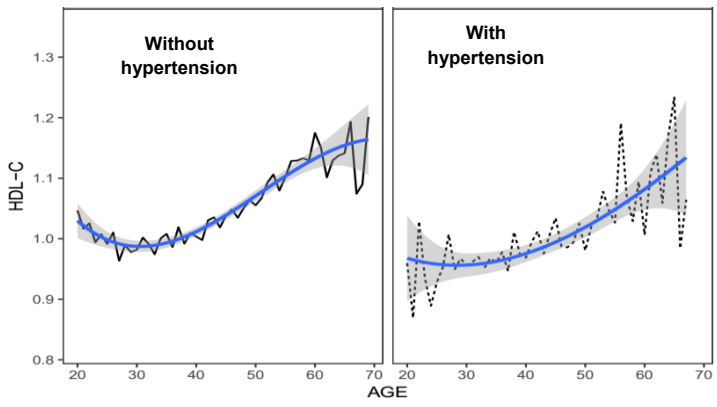


Men

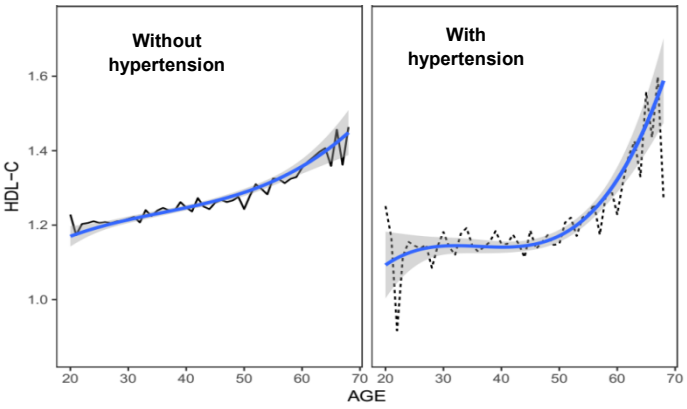


Women

HDL-C

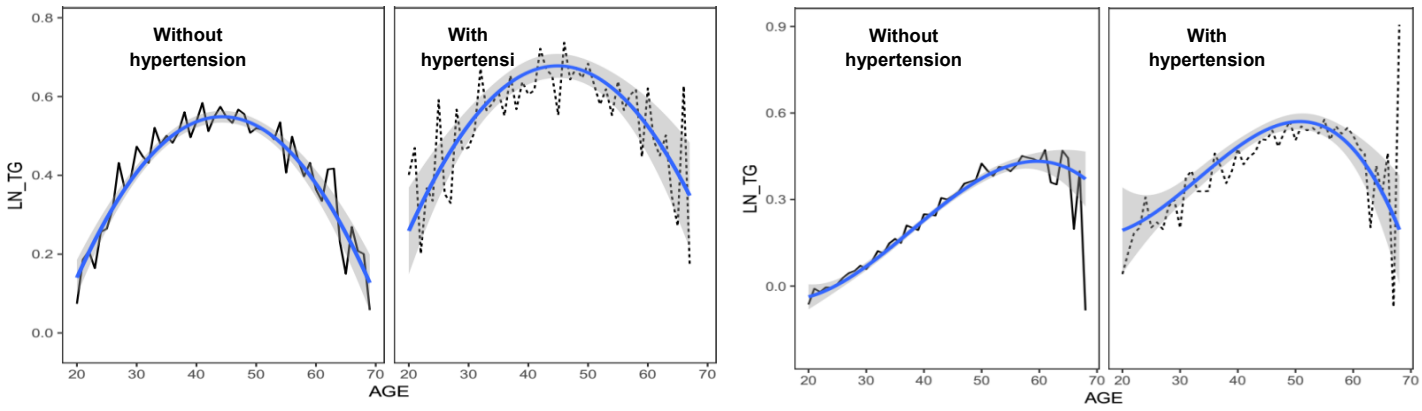


Men



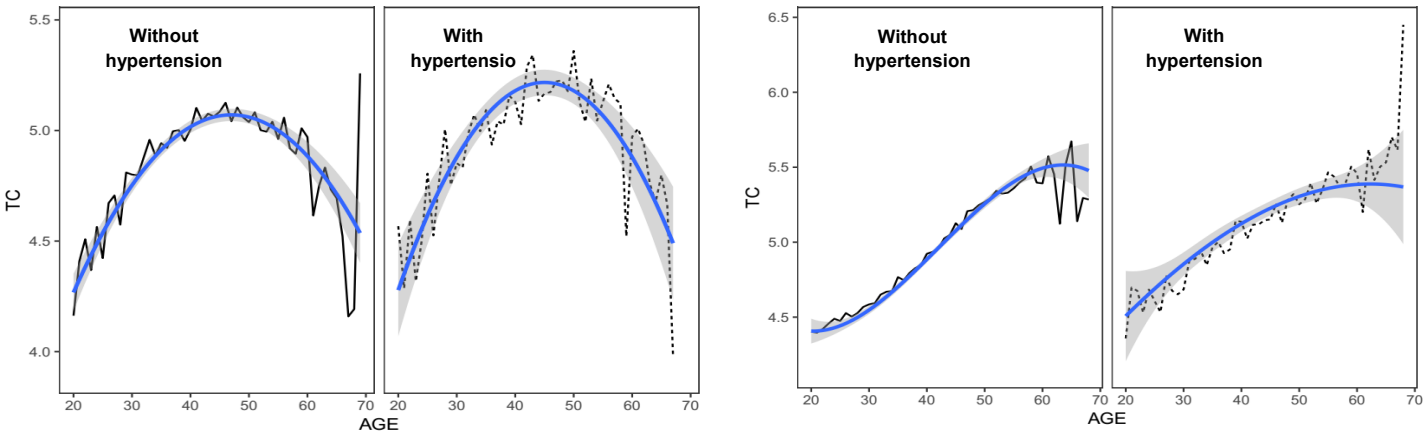
Women

TG



Men Women

TC



Men Women

In each graph, age is represented on the horizontal axis, and changes of MRFs are shown as a function of age, age^2, and age^3

BMI: body mass index; **WC:** waist circumference; **FPG:** fasting plasma glucose; **SBP:** systolic blood pressure; **DBP:** diastolic blood pressure; **HDL-C:** high-density lipoprotein cholesterol; **TG**: triglyceride; **TC**: total cholesterol; **MRFs**: metabolic risk factors