

SUPPLEMENT

How does age modify the association between adiposity and mortality? A prospective cohort study from the UK Biobank using flexible parametric survival models

Content:

Supplementary Table 1. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist of items that should be included in reports of cohort studies.

Supplementary Table 2. Description of variables included from UK Biobank Data Showcase.

Supplementary Figure 1. Number of participants in each step of the inclusion and exclusion process.

Supplementary Figure 2. Distribution of deaths by age at death in the total sample (n=369,752; 10,660 deaths).

Supplementary Table 3. Characteristics of participants by strata of Fat Mass Index.

Supplementary Table 4. Characteristics of participants by strata of Lean Mass Index.

Supplementary Table 5. Characteristics of participants by strata of waist circumference.

Supplementary Table 6. Characteristics of participants by strata of Body Fat Percentage.

Supplementary Table 7. Bivariate correlations for the total sample, sex and age strata.

Supplementary Figure 3. Time-varying hazard ratios by categories of waist circumference and body fat percentage.

Supplementary Figure 4. Time-varying hazard ratios stratified for women and men.

Supplementary Figure 5. Time-varying hazard ratios in never smokers by categories of waist circumference and body fat percentage.

Supplementary Figure 6. Time-varying hazard ratios in people who reported no weight change in previous year to the baseline assessment.

Supplementary Table 1. Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) checklist of items that should be included in reports of cohort studies.

	Item No	Recommendation	Location
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	Title page (page 1)
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	Abstract (page 2)
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Introduction, paragraphs 1-3 (page 3)
Objectives	3	State specific objectives, including any prespecified hypotheses	Introduction, last paragraph (page 3)
Methods			
Study design	4	Present key elements of study design early in the paper	Methods, first paragraph (page 4)
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Methods, first paragraph (page 4)
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Methods, first paragraph (page 4); "Measures" section, "mortality" subsection (pages 4,5); "statistical analysis section", second paragraph (pages 5,6)
		(b) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Methods, "Measures" section (page 4)
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Methods, "Measures" section (page 4); Supplementary Table 1
Bias	9	Describe any efforts to address potential sources of bias	Methods, "statistical analysis" section, second and third paragraphs (pages 5,6)
Study size	10	Explain how the study size was arrived at	Methods, last paragraph of "covariates" section (page 5) and "statistical analysis" section, second paragraph (page 6).
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Methods, "statistical analyses" section (page 5). Supplementary Table 1.
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Methods, "statistical analyses" section (pages 5,6).
		(b) Describe any methods used to examine subgroups and interactions	Methods, "statistical analyses" section, third paragraph (page 6).
		(c) Explain how missing data were addressed	Methods, last paragraph of "covariates" section (page 5).
		(d) If applicable, explain how loss to follow-up was addressed	Methods, "statistical analyses" section (page 6).
		(e) Describe any sensitivity analyses	Methods, "statistical analyses" section, third paragraph (page 6).

Results

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	Supplementary Figure 1 Supplementary Figure 1 Supplementary Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	Table 1 and supplementary tables 2-5 Table 1 and supplementary figure 1 Results, first paragraph (page 6)
Outcome data	15*	Report numbers of outcome events or summary measures over time	Results, first paragraph (page 6) and Supplementary Figure 2.
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (b) Report category boundaries when continuous variables were categorized (c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	Results section (pages 6-8), Figures 1 and 2, and Supplementary Figures 3-6 Results section (pages 6-8), Table 1 and supplementary files. NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Results (pages 6-8), Figure 2 and supplementary figures 3-6
Discussion			
Key results	18	Summarise key results with reference to study objectives	Discussion paragraphs 1, 2, 3 (page 8), and 5 (page 9)
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Discussion paragraph 7 (pages 9,10)
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Discussion section (pages 8-10)
Generalisability	21	Discuss the generalisability (external validity) of the study results	Discussion, “strengths and limitation” section (pages 9, 10)
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA
	Item No	Recommendation	Location
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract (b) Provide in the abstract an informative and balanced summary of what was done and what was found	Title page Abstract
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	Introduction, paragraphs 1-3
Objectives	3	State specific objectives, including any prespecified hypotheses	Introduction, last paragraph
Methods			
Study design	4	Present key elements of study design early in the paper	Methods, first paragraph

Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	Methods, first paragraph
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	Methods, first paragraph; “Measures” section, “mortality” subsection; “statistical analysis section”, second paragraph
		(b) For matched studies, give matching criteria and number of exposed and unexposed	Not applicable
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Methods, “Measures” section
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Methods, “Measures” section; Supplementary Table 1
Bias	9	Describe any efforts to address potential sources of bias	Methods, “statistical analysis” section, second and third paragraphs
Study size	10	Explain how the study size was arrived at	Methods, last paragraph of “covariates” section and “statistical analysis” section, second paragraph.
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Methods, “statistical analyses” section. Supplementary Table 1.
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	Methods, “statistical analyses” section
		(b) Describe any methods used to examine subgroups and interactions	Methods, “statistical analyses” section, third paragraph
		(c) Explain how missing data were addressed	Methods, last paragraph of “covariates” section
		(d) If applicable, explain how loss to follow-up was addressed	Methods, “statistical analyses” section
		(e) Describe any sensitivity analyses	Methods, “statistical analyses” section, third paragraph
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Supplementary Figure 1
		(b) Give reasons for non-participation at each stage	Supplementary Figure 1
		(c) Consider use of a flow diagram	Supplementary Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Table 1 and supplementary tables 2-5
		(b) Indicate number of participants with missing data for each variable of interest	Table 1 and supplementary figure 1
		(c) Summarise follow-up time (eg, average and total amount)	Results, first paragraph
Outcome data	15*	Report numbers of outcome events or summary measures over time	Results, first paragraph and Supplementary Figure 2.
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	Results text, Figures 1 and 2, and Supplementary Figures 3-6
		(b) Report category boundaries when continuous variables were categorized	Results section, Table 1 and supplementary files.
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	Results, Figure 2 and supplementary figures 3-6

Discussion			
Key results	18	Summarise key results with reference to study objectives	Discussion paragraphs 1, 2, 3, 5
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Discussion paragraph 7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Discussion section
Generalisability	21	Discuss the generalisability (external validity) of the study results	Discussion, “strengths and limitation” section.
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Funding section

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at <http://www.strobe-statement.org>.

Supplementary Table 2. Description of variables included from UK Biobank Data Showcase.

Item	UK Biobank Field ID(s)	Measurement item(s)	Definition/data coding	Notes
Alcohol	Combinations of n_20117_0_0 & n_1558_0_0	(Questionnaire) self-reported drinking status and drinking frequency	Never = n_20117_0_0 == 0	https://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=20117 https://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=1558
			Previous = n_20117_0_0 == 1	
			Current, <3times/week = 2 if n_20117_0_0 == 2 & (n_1558_0_0 == 3 n_1558_0_0 == 4 n_1558_0_0 == 5	
			Current, ≥3times/week = 3 if n_20117_0_0 == 2 & (n_1558_0_0 == 1 n_1558_0_0 == 2	
Anorexia, bulimia or other eating disorder	n_20002_0_0 – n_20002_0_28	(Interview) self-reported anorexia/bulimia/other eating disorder	if `x`==1470	https://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=20002
Attendance/disability/mobility allowance	N_6146_0_0	(Questionnaire) self-reported attendance, disability or mobility allowance	Attendance allowance =1 Disability living allowance = 2 Blue badge =3	http://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=6146
Birthday	n_34_0_0 & n_52_0_0	(Registry, updated by participant) year and month of birth	Date set to 15th for all participants	https://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=34 https://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=52
Body mass index	n_21001_0_0	Measured height and weight	18.5-24.9 kg/m ² (Normal weight) =0 25-29.9 kg/m ² (Overweight) =1 30-34.9 kg/m ² (Obese class I) = 2 ≥35 kg/m ² (Obese class II) = 3	http://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=21001
Cancer at baseline	n_2453_0_0	(Questionnaire) self-reported cancer	If `x`==1	http://biobank.ctu.ox.ac.uk/crystal/coding.cgi?id=6
	n_20001_0_0 – n_20001_0_5	(Interview) self-reported cancer excluding non-melanoma skin cancer	If `x` != . & `x` != 1060 `x` != 1061 `x` != 1062 `x` != 1073	http://biobank.ctu.ox.ac.uk/crystal/field.cgi?id=40006
				http://biobank.ctu.ox.ac.uk/crystal/field.cgi?id=40013&nl=1

	s_40006_0_0 – s_40006_31_0	(Cancer Registry) Any cancer-type (C-D48) excluding non-melanoma skin cancers (ICD-10; C44, ICD-9; 173)		
Chronic Obstructive Pulmonary Disease	ts_42016_0_0	(Algorithmically defined outcomes)	If 'x' < assessment date	http://biobank.ctsu.ox.ac.uk/crystal/refer.cgi?id=4125
		COPD from self-report or hospital admission EHR		
Country	n_54_0_0	(Automatically acquired at participant consent) UK Biobank assessment centre		https://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=54
Chronic/degenerative neurological problem	n_20002_0_0 – n_20002_0_28	(Interview) self-reported chronic/degenerative neurological problem, Parkinson's disease, dementia/Alzheimer's/cognitive impairment, motor neuron disease, myasthenia gravis, multiple sclerosis, other demyelinating disease (not multiple sclerosis)	if `x`==1258 `x`==1259	https://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=20002
			`x`==1260 `x`==1261	
			`x`==1262 `x`==1263	
			`x`== 1397	

Chronic immunological or systemic diseases	n_20002_0_0 – n_20002_0_28	(Interview) self-reported rheumatoid arthritis, vasculitis, giant cell/temporal arteritis, polymyalgia rheumatica, Wegners granulmatosis, microscopic polyarteritis, polyartertis nodosa, systemic lupus erythematosis/sle, sjogren's syndrome/sicca syndrome, dermatopolymyositis, dermatomyositis, polymyositis, scleroderma/systemic sclerosis, chronic fatigue syndrome, antiphospholipid syndrome	if `x`==1464 `x`==1372 `x`==1376 `x`==1377 `x`==1378 `x`==1379 `x`==1380 `x`==1381 `x`==1382 `x`==1383 `x`==1480 `x`==1481 `x`==1384 `x`==1482 `x`==1564	Individuals reporting; sarcoidosis, connective tissue disorder, Raynaud's phenomenon/disease not excluded
				Allergy/hypersensitivity/anaphylaxis variables are not considered
Chronic respiratory diseases (not including COPD)	n_20002_0_0 – n_20002_0_28	(Interview) self-reported bronchiectasis, interstitial lung disease, asbestosis, pulmonary fibrosis, fibrosing alveolitis/unspecified alveolitis, respiratory failure	if `x`==1114 `x`==1115 `x`==1120 `x`==1121 `x`==1122 `x`==1124	Individuals reporting; other respiratory problems, sleep apnea, pleurisy, pneumothorax, spontaneous pneumothorax/recurrent pneumothorax, pleural plaques (not known asbestosis), pleural effusion not excluded as these are not chronic or not debilitating respiratory infection, pneumonia, lung abscess, empyema not included as individuals with these conditions are unlikely to attend the examination center
Chronic widespread pain	n_2956_0_0	(Questionnaire)	if `x`==1	doi: 10.1007/s11657-015-0252-1
		"Have you had pains all over the body for more than 3 months?"		
Cardiovascular disease at baseline	n_42000_0_0	(Algorithmically defined outcomes)	ICD-10:	http://biobank.cts.ox.ac.uk/crystal/refer.cgi?id=461
	n_42006_0_0	myocardial infarction, stroke, ischaemic stroke, subarachnoid haemorrhage, brain haemorrhage	MI: I21, I22, I23, I24.1, I25.2	http://biobank.cts.ox.ac.uk/crystal/refer.cgi?id=462
	n_42008_0_0 n_42010_0_0		Subarachnoid haemorrhage: I60	https://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=42008 https://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=42010

	n_42012_0_0		Intracerebral haemorrhage: I61	
			Cerebral infarction: I63	
			Stroke, not specified as haemorrhage or	
			Infarction: I64.X	
			ICD-9:	
			MI: 410, 411, 412.X, 429.79	
			Subarachnoid haemorrhage: 430.X	
			Intracerebral haemorrhage: 431.X	
			Occlusion of cerebral arteries: 434.X	
			Cerebral thrombosis: 434.0	
			Cerebral embolism: 434.1	
			Cerebral artery occlusion, unspecified: 434.9	
			Acute, but ill-defined, cerebrovascular disease: 436.X	
	s_41270_0_0 ts_41280_0_0 s_41271_0_0 ts_41281_0_0	(Hospital In-patient data)	ICD-10:	http://biobank.ctsu.ox.ac.uk/crystal/field.cgi?id=41270
		Angina, heart failure	Angina (I20): I20.0, I20.1, I20.8, I20.9	
			Heart failure (I11, I13, I50): I50.0, I50.1, I50.9, I11.0, I11.9, I13.0, I13.2, I13.9)	
			ICD-9:	
			Angina: 4139	
			Heart failure: 4280, 4281, 4289	
Date lost to follow-up	ts_191_0_0	(multiple sources) date which a person is believed to be lost to follow-up		http://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=191
Date of attending UK Biobank assessment centre	ts_53_0_0	(Acquired at UK Biobank Reception)	Wales = if `x`== 11003 `x`==11022 `x`==11023	http://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=54
			Scotland = if `x`== 11005 `x`==11004	
			England = if none of the above satisfied	

Date of Death	ts_40000_0_0	(Death register) date of death		
Depression	n_20002_0_0 – n_20002_0_28	(Interview) self-reported depression	If 'x'== 1286	Not including post-natal depression
Diabetes (excluding gestational diabetes)	n_2443_0_0	(Questionnaire) self-reported diabetes	If 'x'==1 & n_4041_0_0 (gestational diabetes) !=1	
	N_6153_0_0 – n_6153_0_3 (women)	(Questionnaire) self-reported Insulin user	If 'x'==3	
	n_6177_0_0 – n_6177_0_2 (men)			
	n_20002_0_0 – n_20002_0_28	(Interview) self-reported diabetes	if 'x'== 1220 'x'== 1222 'x'==1223	
	n_30750_0_0	(Biochemistry) HbA1c	If 'x' ≥48 mmol/l	
Duration of moderate activity	n_894_0_0	(Questionnaire) minutes of moderate activity on a typical day	IPAQ data processing	http://biobank.ndph.ox.ac.uk/showcase/showcase/docs/ipaq_analysis.pdf
Duration of vigorous activity	n_914_0_0	(Questionnaire) minutes of vigorous activity on a typical day	IPAQ data processing	http://biobank.ndph.ox.ac.uk/showcase/showcase/docs/ipaq_analysis.pdf
Duration of walks	n_874_0_0	(Questionnaire) minutes of walking on a typical day	IPAQ data processing	http://biobank.ndph.ox.ac.uk/showcase/showcase/docs/ipaq_analysis.pdf
Education	n_6138_0_0 - n_6138_0_5	(Questionnaire) self-reported qualifications	College/University degree = if 'x'== 1	7 answering options
			A/AS/O/GCSE/CSE/NVQ/HND/HNC/Other professional qualifications = if 'x'== 2 'x'== 3 'x'== 4 'x'== 5 'x'== 6	structure which accounts for all
			No qualifications= if 'x'== -7	Original categories do not have a clear ordinal
Employment	n_6142_0_0 - n_6142_0_0	(Questionnaire) self-reported 'current situation'	Employed = if 'x'== 1	
Ethnicity	n_21000_0_0	(Questionnaire) amalgam of sequential branching questions	White = if 'x'==1 'x'==1001 'x'==1002 'x'==1003	
			Other = if above not satisfied	

Fat Mass Index	n_23100_0_0 (whole body fat mass)	Bioimpedance measurements	Fat mass index = whole body fat / height ² Maintaining the sex-specific distribution in the BMI categories, categorization as: low =0 medium-low =1 medium-high =2 high =3	https://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=23278 https://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=12144
	n_12144_0_0 (height)	Body size measurements		
Fruit/vegetable intake (servings/week)	n_1289_0_0 n_1299_0_0 n_1309_0_0 n_1319_0_0	(Questionnaire) self-reported frequency of cooked vegetable intake, salad/raw vegetable intake, fresh fruit intake, dried fruit intake	Less than one = 0.5	Included as part of diet pattern variable
			Otherwise, number of reported tablespoons (vegetables) and pieces (fruit) as reported	
General health	n_2178_0_0	(Questionnaire) Self-perceived overall health rating	Poor = 4	
Healthy diet pattern	Derived for this dataset	Composite of self-reported fish, fruit/vegetable and processed/red meat intake	1 if meeting 2 of the 3 food item targets	Fish: >=2 servings/week, including 1 with oily fish: https://www.nhs.uk/live-well/eat-well/eight-tips-for-healthy-eating/
			0 if not meeting 2 of the targets	Fruit/vegetables: >=5 servings/day: https://www.nhs.uk/live-well/eat-well/5-a-day-what-counts/ + doi: 10.1016/S2468-2667(18)30200-7
				Processed/red meat intake: <= 3 servings of red meat/week & <=1 serving of processed meat/week: https://www.ncbi.nlm.nih.gov/pubmed/30467019 + doi: 10.1016/S2468-2667(18)30200-7
Hypertension	n_6150_0_0 – n_6150_0_3	(Questionnaire) self-reported High Blood Pressure	If 'x'==4	
	N_6153_0_0 – n_6153_0_3 (women)	(Questionnaire) self-reported blood pressure medication	If 'x'==2	
	n_6177_0_0 – n_6177_0_2 (men)			
	n_4080_0_0 n_4079_0_0	Measured (manual or automated) systolic and diastolic BP	If SBP≥140 DBP≥90	
	n_93_0_1 n_94_0_1			
	n_20002_0_0 – n_20002_0_28	(Interview) self-reported hypertension, essential hypertension	if 'x'==1065 'x'==1072	

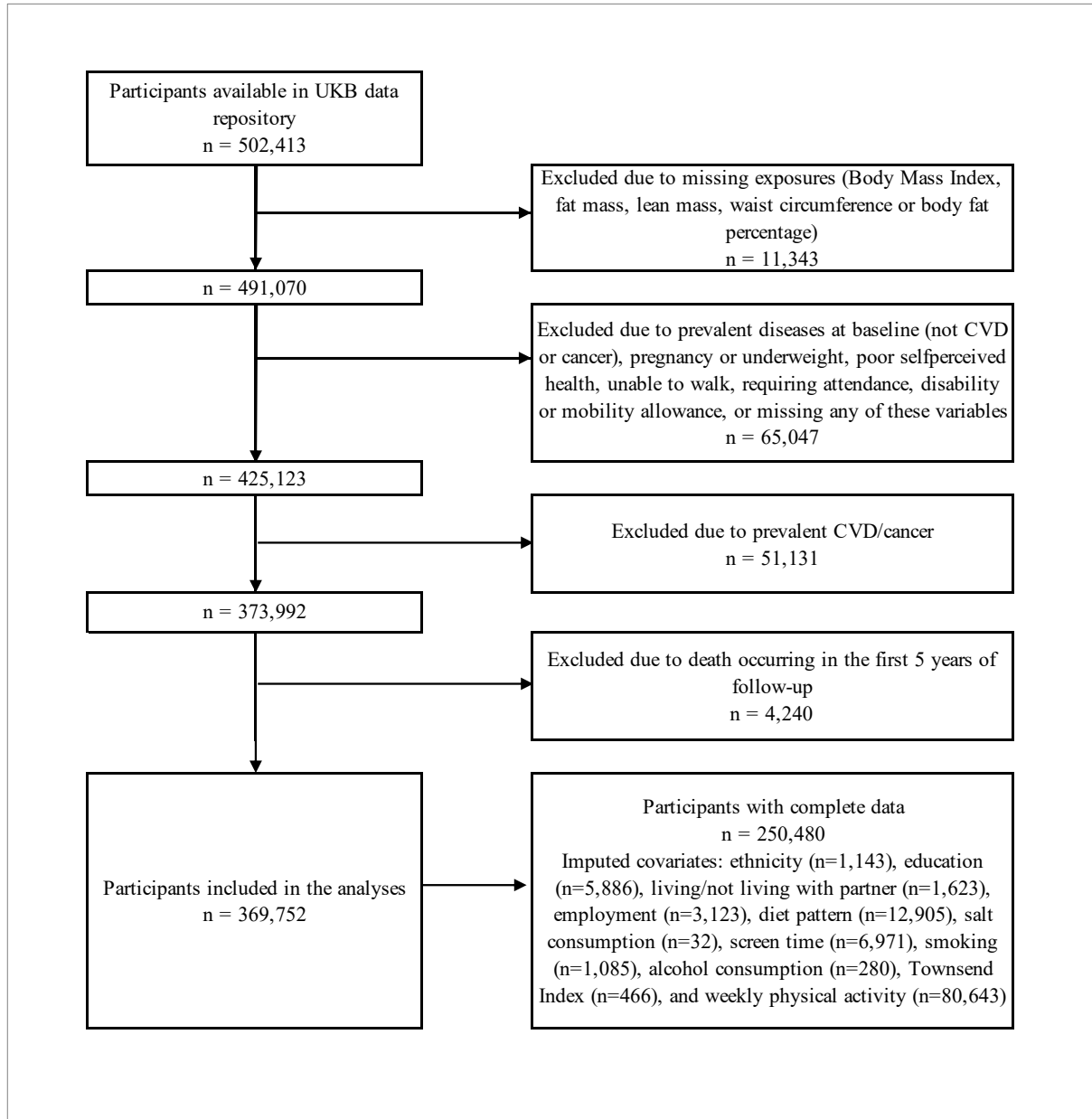
Income	n_738_0_0	(Questionnaire) Average total household income before tax	<£18,000 = 0 £18,000–51,999 = 1 >£52,000 = 2 Missing = 3	http://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=738
Lean Mass Index	n_23279_0_0 (total fat-free mass)	Bioimpedance measurements	Lean mass index = whole body fat / height ² Maintaining the sex-specific distribution in the BMI categories, categorization as:	https://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=23279 https://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=12144
	n_12144_0_0 (height)	Body size measurements	low = 0 medium-low = 1 medium-high = 2 high = 3	
Liver failure/cirrhosis	n_20002_0_0 – n_20002_0_28	(Interview) self-reported liver failure/cirrhosis, primary biliary cirrhosis, alcoholic liver disease / alcoholic cirrhosis	if `x`==1158 `x`==1506 `x`==1604	
Marital status	Combinations of n_709_0_0 and n_6414_0_0 - n_6414_0_4	(Questionnaire) self-reported individuals (including yourself) living in household and relation to those individuals	Not married/living with partner = if n_709_0_0 == 1	
			Married/living with partner = if n_709_0_0 > 1 & n_6414_0_0 - n_6414_0_4 == 1	
No. of days/week walking	n_864_0_0	(Questionnaire) days of ≥10-minute walking in last week	IPAQ data processing	http://biobank.ndph.ox.ac.uk/showcase/showcase/docs/ipaq_analysis.pdf
No. of days/week moderate physical activity	n_884_0_0	(Questionnaire) days of ≥10-minute moderate activity in last week	IPAQ data processing	http://biobank.ndph.ox.ac.uk/showcase/showcase/docs/ipaq_analysis.pdf
No. of days/week vigorous physical activity	n_904_0_0	(Questionnaire) days of ≥10-minute vigorous activity in last week	IPAQ data processing	http://biobank.ndph.ox.ac.uk/showcase/showcase/docs/ipaq_analysis.pdf
Non-oily Fish intake (servings/week)	n_1339_0_0	(Questionnaire) self-reported frequency of non-oily fish intake	Never = 0	Included as part of diet pattern variable
			less than once a week = 0.5	
			Once a week = 1	
			2-4 times a week = 3	
			5-6 times a week = 5.5	
			Once or more daily = 7	
Oily Fish intake (servings/week)	n_1329_0_0	(Questionnaire) self-reported frequency of oily fish intake	Never = 0	Included as part of diet pattern variable
			less than once a week = 0.5	
			Once a week = 1	

			2-4 times a week = 3	
			5-6 times a week = 5.5	
			Once or more daily = 7	
Primary cause of death	s_40001_0_0	(Death register) underlying/primary cause of death		http://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=40001
Processed meat (servings/week)	n_1349_0_0	(Questionnaire) self-reported frequency of processed meat intake	Never = 0	Included as part of diet pattern variable
			less than once a week = 0.5	
			Once a week = 1	
			2-4 times a week = 3	
			5-6 times a week = 5.5	
			Once or more daily = 7	
Psychological or psychiatric problems	n_20002_0_0 – n_20002_0_28	(Interview) self-reported schizophrenia, mania/bipolar disorder/manic depression, deliberate self-harm/suicide attempt, post-traumatic stress disorder	If 'x'== 1289 'x'== 1290	
			'x'== 1291 'x'== 1469	
Red meat (servings/week)	n_1369_0_0	(Questionnaire) self-reported frequency of beef, lamb/mutton and pork intake	Never = 0	Included as part of diet pattern variable
	n_1379_0_0		less than once a week = 0.5	
	n_1389_0_0		Once a week = 1	
			2-4 times a week = 3	
			5-6 times a week = 5.5	
			Once or more daily = 7	
Salt consumption	N_1478_0_0	(Questionnaire) self-reported frequency of adding salt to the	1 = never/rearely	http://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=1478

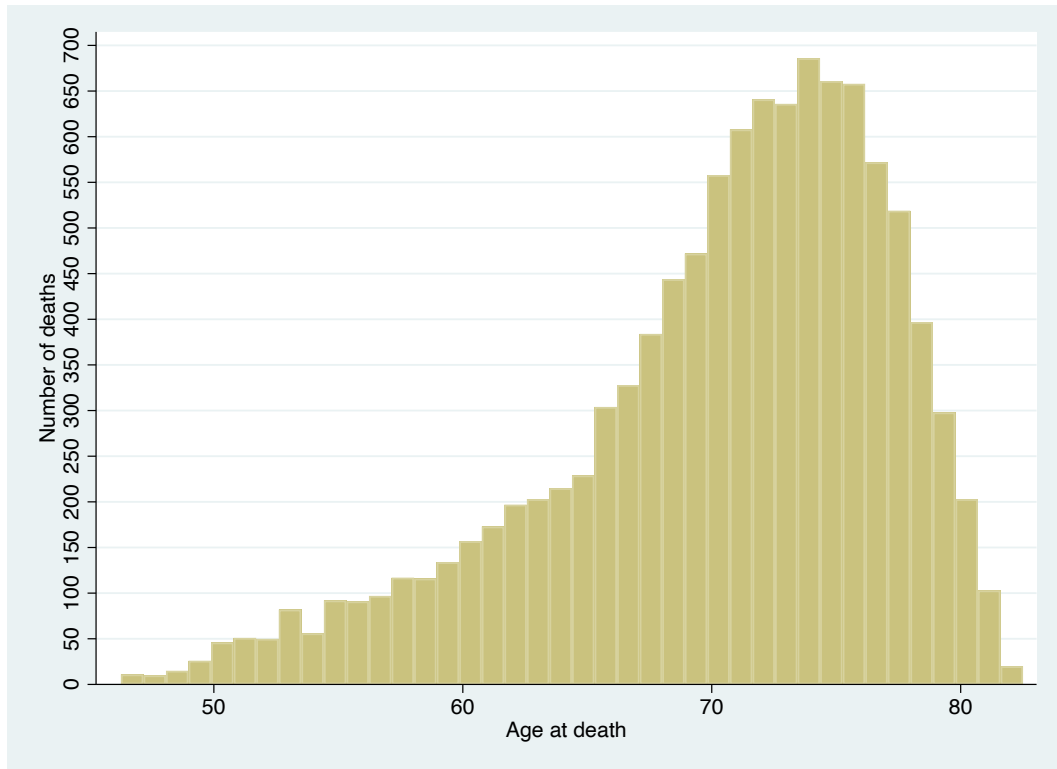
		food, not including salt used in cooking.	2 = sometimes 3 = Usually 4 = Always	Those selecting the option "prefer not to answer" in the questionnaire were considered as missings and excluded.
Screen time	n_1070_0_0 & n_1080_0_0	(Questionnaire) self-reported time-use of tv-viewing and non-occupational PC-use, h/day	TV-viewing = 0.5 if `x`== 'less than 1h' PC-use = 0.5 if `x`== 'less than 1h'	
Sex	n_31_0_0	(Registry, updated by participant)		
Sleep duration	n_1160_0_0	(Questionnaire) self-reported hours of sleep/day	Sleep duration = 8 if `x`=='missing'	
Smoking	n_20116_0_0	(Questionnaire) self-reported smoking-status		
Stair climbing	n_943_0_0	(Questionnaire) "At home, during the last 4 weeks, about how many times a DAY do you climb a flight of stairs? (approx 10 steps)"	Never = 0 1-5 flights/day=1 6-10 flights/day=2 11-15 flights/day=3 ≥16 flights/day=4	http://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=943
Statins use	n_20003_0_0 – n_20003_0_47	(Interview) self-reported use of statins	Atorvastatin, Fluvastatin, Pravastatin, Rosuvastatin, Simvastatin	https://www.nhs.uk/conditions/statins/
Substance abuse/dependency	n_20002_0_0 – n_20002_0_28	(Interview) self-reported alcohol dependency, opioid dependency, other substance abuse/dependency	if `x`==1408 `x`== 1408 `x`== 1410	

Townsend	n_189_0_0	Townsend deprivation index calculated immediately prior to participant joining UK Biobank. Based on the preceding national census output areas. Each participant is assigned a score corresponding to the output area in which their postcode is located.		
Walking pace	n_924_0_0	(Interview) self-reported usual walking pace	Slow pace = 1 Steady average pace =2 Brisk pace =3	http://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=924
Waist circumference	n_48_0_0	Body size measures	Using the residuals from regressing the waist circumference (cm) on the BMI (kg/m ²) and categorization maintaining the sex-specific distribution in the BMI categories as: Low =0 medium-low =1 medium-high =2 high =3	https://biobank.ndph.ox.ac.uk/showcase/field.cgi?id=48

Supplementary Figure 1. Number of participants in each step of the inclusion and exclusion process. Exclusions due to prevalent diseases at baseline included cancer (excluding non-melanoma skin cancer), cardiovascular diseases, chronic neurological degenerative problems, widespread pain, respiratory diseases (including chronic obstructive pulmonary disease), liver failure or cirrhosis, psychological or psychiatric problems, substance abuse or dependency, or eating disorders.



Supplementary Figure 2. Distribution of deaths by age at death in the total sample (n=369,752; 10,660 deaths).



Supplementary Table 3. Baseline characteristics of the included participants (n=369,752) by strata of Fat Mass Index.

	Low (n= 127,236)	Medium-low (n= 161,367)	Medium-high (n= 60,606)	High (n= 20,543)
Age (years), mean (SD)	55.0 (8.2)	56.9 (8.0)	57.4 (7.7)	56.5 (7.7)
Age subgroups				
<50 years old	32.3	23.4	20.7	23.3
50-59 years old	34.6	33.9	34.6	37.1
60-69 years old	32.8	42.3	44.3	39.2
≥70 years old	0.3	0.4	0.5	0.4
Sex, women	65.1	46.4	48.7	63.3
Ethnicity				
White	95.4	94.8	94.1	94.1
Asian	2.1	2.3	2.0	1.3
Black	1.0	1.6	2.3	3.0
Others / Mixed background	1.5	1.4	1.5	1.6
Townsend Deprivation Index, mean (SD)	2.1 (1.4)	2.1 (1.4)	2.0 (1.4)	1.8 (1.4)
Education				
No qualifications	10.1	15.0	18.8	19.3
Not college/university degree	47.5	51.5	53.5	55.4
University degree	42.4	33.5	27.7	25.3
Living with partner	73.9	76.9	74.7	67.8
Employment				
Unemployed	6.7	5.0	5.5	7.5
Employed	67.5	62.7	61.3	62.2
Retired	25.9	32.3	33.2	30.3
Total PA (MET-min/week), mean (SD)	2935.4 (2696.4)	2689.3 (2644.8)	2392.8 (2354.0)	2043.5 (2354.0)
Diet pattern, meeting 2 targets	73.3	68.4	65.1	63.4
Salt intake				
Never / Rarely	60.3	55.5	52.4	51.4
Sometimes	26.4	28.5	29.6	29.9
Usually	9.7	11.7	13.0	12.9
Always	3.6	4.3	5.1	5.8
Alcohol intake				
Never	3.5	3.6	4.4	5.7
Previous	2.5	2.4	2.9	3.9
Current, <3 times/week	46.0	46.5	51.6	61.0
Current, ≥3 times/week	48.0	47.5	41.1	29.4
Smoking status				
Never	61.6	56.3	53.1	54.9
Previous	28.5	34.5	38.3	37.2
Current	9.9	9.2	8.6	7.8
Screen time				
<2 hours / day	18.4	9.6	6.5	5.0
2-3 hours / day	23.6	18.1	14.0	12.0
3-4 hours / day	23.3	23.3	21.5	19.2
4-5 hours / day	16.4	20.6	21.5	21.2
>5 hours / day	18.2	28.4	36.4	42.7
History of depression	4.0	4.3	5.2	7.2

Number varies from 289,109 (total physical activity) to 369,752 because of missing data. MET: metabolic equivalent; MIN: minutes; PA: physical activity. Values are percentages unless stated otherwise. Dietary pattern is based on meeting at least two out of three healthy eating targets related to food types: 1) ≤3 weekly servings of red meat and ≤1 servings/week of processed meat; 2) ≥2 servings per week of fish including at least one with oily fish; 3) ≥5 servings per day of fruits and vegetables.

Supplementary Table 4. Baseline characteristics of the included participants (n=369,752) by strata of Lean Mass Index.

	Low (n=127,099)	Medium-low (n=161,564)	Medium-high (n=60,518)	High (n=20,571)
Age (years), mean (SD)	56.9 (8.0)	56.3 (8.1)	55.6 (7.8)	54.7 (7.8)
Age subgroups				
<50 years old	23.5	26.2	28.9	31.7
50-59 years old	34.0	34.0	35.3	37.5
60-69 years old	42.0	39.4	35.4	30.6
≥70 years old	0.5	0.4	0.4	0.3
Sex, women	65.1	46.4	48.6	63.3
Ethnicity				
White	95.0	95.2	94.4	93.2
Asian	2.8	1.9	1.5	1.1
Black	0.9	1.5	2.4	3.8
Others / Mixed background	1.3	1.4	1.7	1.8
Townsend Deprivation Index, mean (SD)	2.2 (1.4)	2.1 (1.4)	2.0 (1.4)	1.8 (1.4)
Education				
No qualifications	13.1	14.3	15.8	15.8
Not college/university degree	48.5	50.4	53.8	56.6
University degree	38.5	35.3	30.4	27.6
Living with partner	74.8	76.5	74.0	67.7
Employment				
Unemployed	6.3	5.2	5.6	7.4
Employed	59.9	65.0	68.4	69.9
Retired	33.8	29.8	26.0	22.7
Total PA (MET-min/week), mean (SD)	2648.5 (2517.7)	2766.6 (2687.4)	2716.8 (2583.8)	2352.0 (2583.8)
Diet pattern, meeting 2 targets	72.4	68.6	66.1	64.3
Salt intake				
Never / Rarely	58.5	56.0	54.3	52.9
Sometimes	27.1	28.3	29.1	29.7
Usually	10.5	11.6	11.9	12.2
Always	3.9	4.2	4.8	5.2
Alcohol intake				
Never	3.9	3.4	4.2	5.8
Previous	2.5	2.4	2.9	3.6
Current, <3 times/week	45.2	46.6	52.6	62.4
Current, ≥3 times/week	48.4	47.6	40.4	28.2
Smoking status				
Never	60.2	56.3	55.1	57.5
Previous	30.5	34.3	35.5	34.1
Current	9.2	9.3	9.4	8.4
Screen time				
<2 hours / day	14.8	11.4	8.9	6.9
2-3 hours / day	21.0	18.9	16.8	14.5
3-4 hours / day	23.4	22.8	21.9	20.8
4-5 hours / day	18.1	19.7	20.5	20.8
>5 hours / day	22.6	27.2	32.0	37.0
History of depression	4.3	4.2	4.9	6.6

Number varies from 289,109 (total physical activity) to 369,752 because of missing data. MET: metabolic equivalent; MIN: minutes; PA: physical activity. Values are percentages unless stated otherwise. Dietary pattern is based on meeting at least two out of three healthy eating targets related to food types: 1) ≤3 weekly servings of red meat and ≤1 servings/week of processed meat; 2) ≥2 servings per week of fish including at least one with oily fish; 3) ≥5 servings per day of fruits and vegetables.

Supplementary Table 5. Baseline characteristics of the included participants (n=369,752) by strata of waist circumference.

	Low (n=127,224)	Medium-low (n=161,377)	Medium-high (n=60,604)	High (n=20,547)
Age (years), mean (SD)	55.0 (8.1)	56.5 (8.0)	57.9 (7.6)	58.7 (7.6)
Age subgroups				
<50 years old	32.0	25.2	19.1	15.9
50-59 years old	35.0	34.6	33.4	32.8
60-69 years old	32.7	39.8	47.1	50.6
≥70 years old	0.3	0.4	0.5	0.7
Sex, women	65.2	46.4	48.6	63.3
Ethnicity				
White	94.3	95.1	95.3	94.8
Asian	1.9	2.2	2.3	2.7
Black	2.1	1.3	1.2	1.2
Others / Mixed background	1.6	1.4	1.2	1.3
Townsend Deprivation Index, mean (SD)	2.1 (1.4)	2.1 (1.4)	2.1 (1.4)	2.0 (1.4)
Education				
No qualifications	13.0	14.0	16.2	18.0
Not college/university degree	52.1	49.9	49.7	50.2
University degree	35.0	36.1	34.1	31.8
Living with partner	74.2	75.9	75.2	71.7
Employment				
Unemployed	6.1	5.5	5.7	6.6
Employed	67.6	64.4	59.0	55.0
Retired	26.3	30.2	35.3	38.4
Total PA (MET-min/week), mean (SD)	2887.7 (2714.7)	2687.1 (2640.5)	2450.6 (2376.8)	2283.7 (2376.8)
Diet pattern, meeting 2 targets	72.1	68.1	66.7	68.1
Salt intake				
Never / Rarely	57.8	56.3	54.7	53.9
Sometimes	27.7	28.2	28.4	28.1
Usually	10.5	11.4	12.1	12.9
Always	4.0	4.1	4.8	5.1
Alcohol intake				
Never	4.2	3.4	3.7	5.0
Previous	2.6	2.4	2.8	3.3
Current, <3 times/week	51.8	45.9	45.4	47.9
Current, ≥3 times/week	41.4	48.2	48.2	43.7
Smoking status				
Never	62.3	56.4	52.6	51.5
Previous	29.7	34.1	36.7	37.7
Current	8.0	9.5	10.7	10.8
Screen time				
<2 hours / day	13.2	11.8	10.1	9.3
2-3 hours / day	20.4	18.9	17.2	16.6
3-4 hours / day	23.2	22.8	22.3	21.7
4-5 hours / day	18.8	19.4	20.0	20.0
>5 hours / day	24.3	27.1	30.4	32.4
History of depression	4.3	4.3	5.0	5.9

Number varies from 289,109 (total physical activity) to 369,752 because of missing data. MET: metabolic equivalent; MIN: minutes; PA: physical activity. Values are percentages unless stated otherwise. Dietary pattern is based on meeting at least two out of three healthy eating targets related to food types: 1) ≤3 weekly servings of red meat and ≤1 servings/week of processed meat; 2) ≥2 servings per week of fish including at least one with oily fish; 3) ≥5 servings per day of fruits and vegetables.

Supplementary Table 6. Baseline characteristics of the included participants (n=369,752) by strata of Body Fat Percentage.

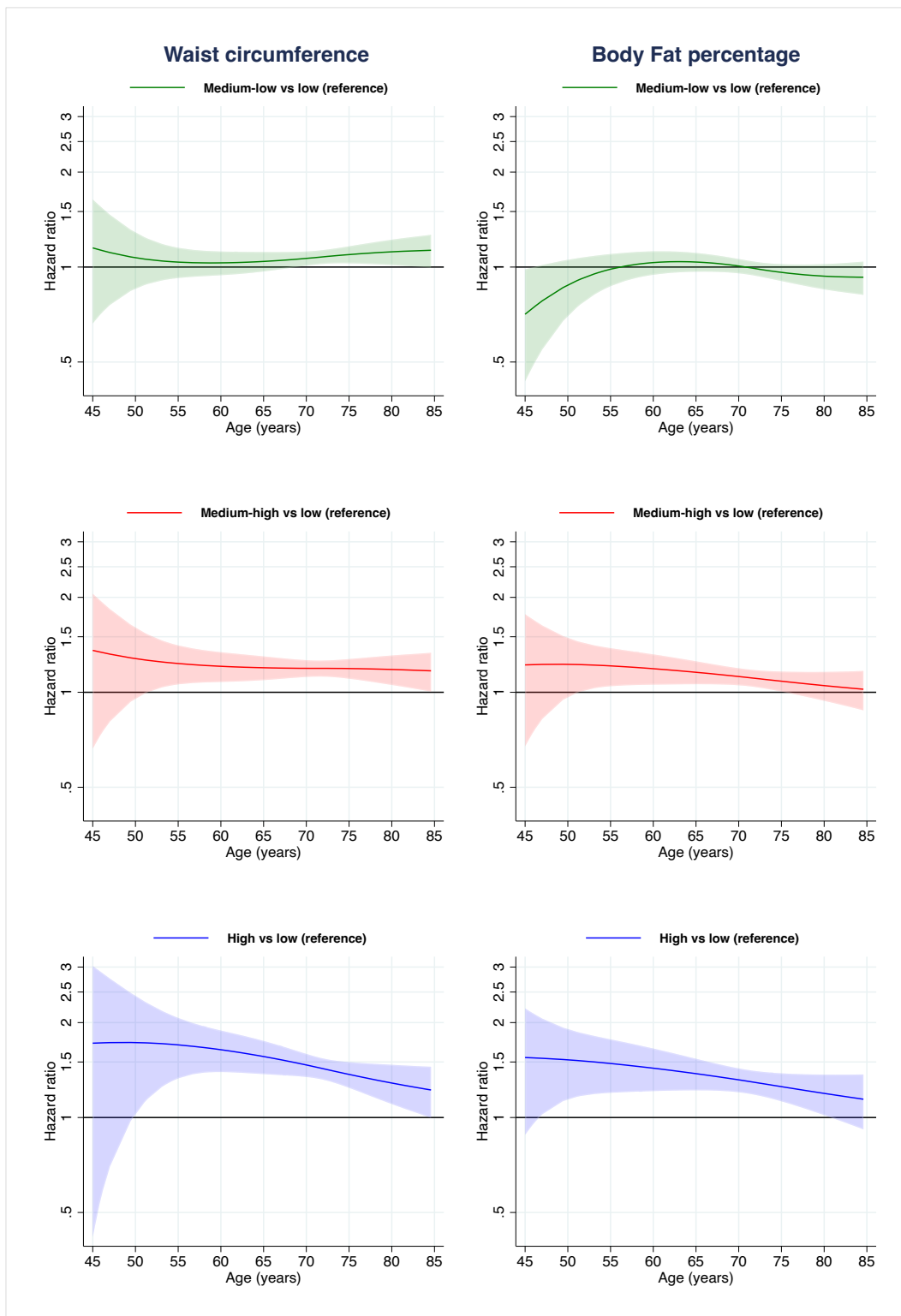
	Low (n=127,495)	Medium-low (n=162,400)	Medium-high (n=59,574)	High (n=20,283)
Age (years), mean (SD)	54.7 (8.2)	56.8 (8.0)	57.9 (7.7)	57.6 (7.7)
Age subgroups				
<50 years old	33.5	23.7	18.7	19.3
50-59 years old	34.6	34.2	34.0	35.8
60-69 years old	31.6	41.7	46.8	44.4
≥70 years old	0.3	0.4	0.5	0.5
Sex, women	65.2	46.3	48.5	64.0
Ethnicity				
White	95.4	94.8	94.1	94.1
Asian	2.0	2.3	2.3	1.6
Black	1.1	1.6	2.2	2.8
Others / Mixed background	1.5	1.4	1.5	1.5
Townsend Deprivation Index, mean (SD)	2.1 (1.4)	2.1 (1.4)	2.0 (1.4)	1.8 (1.4)
Education				
No qualifications	10.1	14.9	19.0	20.9
Not college/university degree	47.8	51.4	53.3	54.5
University degree	42.1	33.7	27.7	24.6
Living with partner	73.8	76.8	74.9	69.0
Employment				
Unemployed	6.7	5.0	5.4	7.5
Employed	68.5	63.2	59.1	57.5
Retired	24.8	31.8	35.5	35.0
Total PA (MET-min/week), mean (SD)	2978.1 (2724.6)	2669.8 (2633.9)	2350.7 (2305.2)	2011.3 (2305.2)
Diet pattern, meeting 2 targets	73.3	68.2	65.1	64.6
Salt intake				
Never / Rarely	60.3	55.5	52.3	51.2
Sometimes	26.4	28.6	29.5	29.7
Usually	9.7	11.7	13.0	13.2
Always	3.6	4.2	5.1	5.9
Alcohol intake				
Never	3.5	3.6	4.3	5.5
Previous	2.5	2.4	3.0	3.9
Current, <3 times/week	46.6	46.6	50.6	59.3
Current, ≥3 times/week	47.4	47.3	42.1	31.3
Smoking status				
Never	61.5	56.5	53.0	53.8
Previous	28.6	34.3	38.5	38.4
Current	9.9	9.2	8.5	7.8
Screen time				
<2 hours / day	18.5	9.6	6.3	4.8
2-3 hours / day	23.6	18.2	13.9	11.3
3-4 hours / day	23.3	23.3	21.4	19.2
4-5 hours / day	16.3	20.6	21.6	21.6
>5 hours / day	18.2	28.3	36.8	43.0
History of depression	4.0	4.3	5.4	7.1

Number varies from 289,109 (total physical activity) to 369,752 because of missing data. MET: metabolic equivalent; MIN: minutes; PA: physical activity. Values are percentages unless stated otherwise. Dietary pattern is based on meeting at least two out of three healthy eating targets related to food types: 1) ≤3 weekly servings of red meat and ≤1 servings/week of processed meat; 2) ≥2 servings per week of fish including at least one with oily fish; 3) ≥5 servings per day of fruits and vegetables.

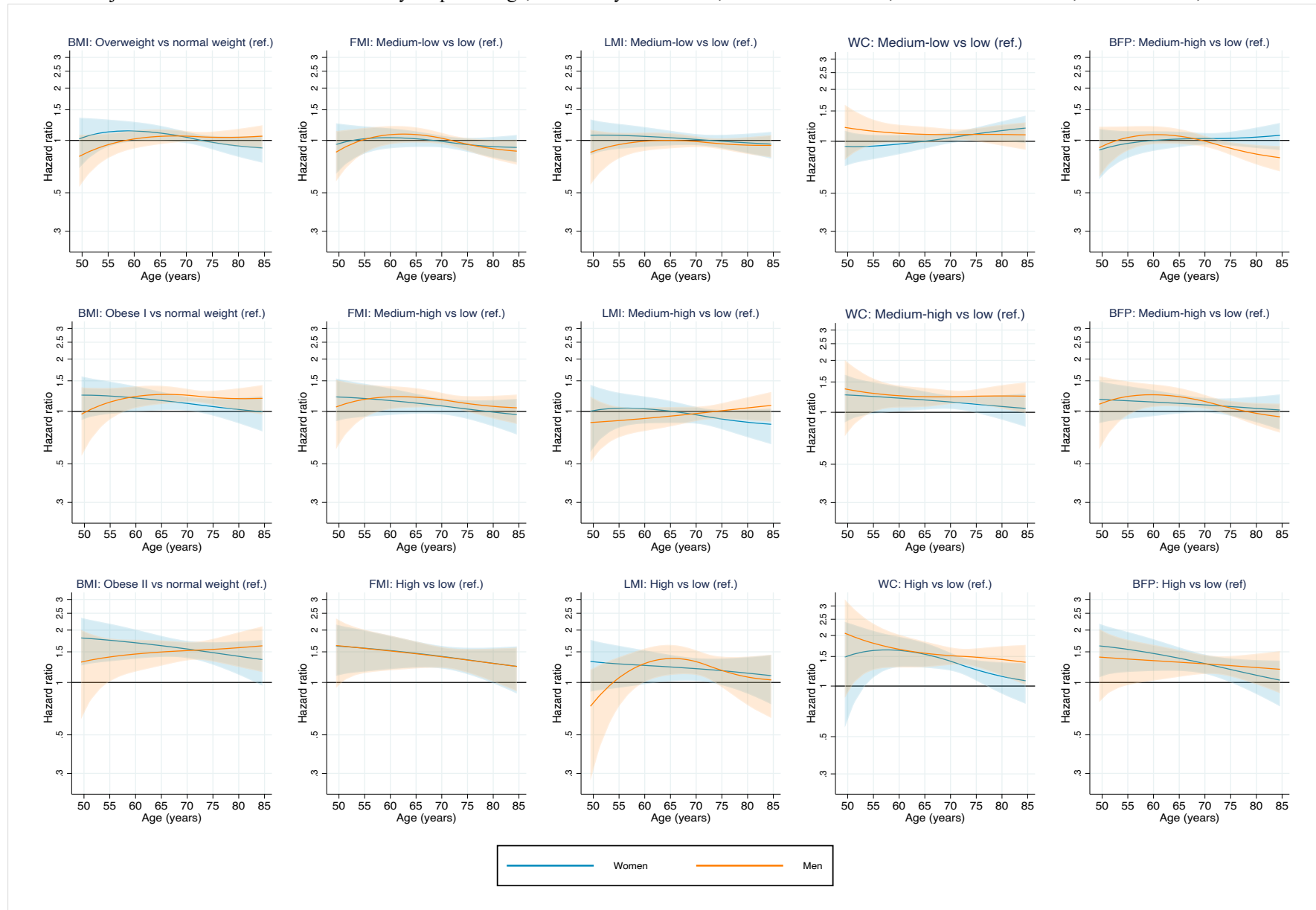
Supplementary Table 7. Bivariate correlations of Body Mass Index (BMI) with Fat Mass Index (FMI), Lean Mass Index (LMI) and Body Fat Percentage (BFP) by sex and age strata.

	BMI-FMI	BMI-LMI	BMI-BFP	FMI-LMI
Women	0.97	0.85	0.85	0.70
Men	0.93	0.87	0.79	0.62
Women, <50 years old	0.98	0.87	0.86	0.73
Women, 50-59 years old	0.97	0.87	0.85	0.72
Women, 60-69 years old	0.97	0.85	0.84	0.67
Women, ≥ 70 years old	0.96	0.84	0.81	0.65
Men, <50 years old	0.94	0.90	0.80	0.67
Men, 50-59 years old	0.94	0.89	0.81	0.67
Men, 60-69 years old	0.93	0.86	0.79	0.61
Men, ≥ 70 years old	0.93	0.87	0.78	0.59

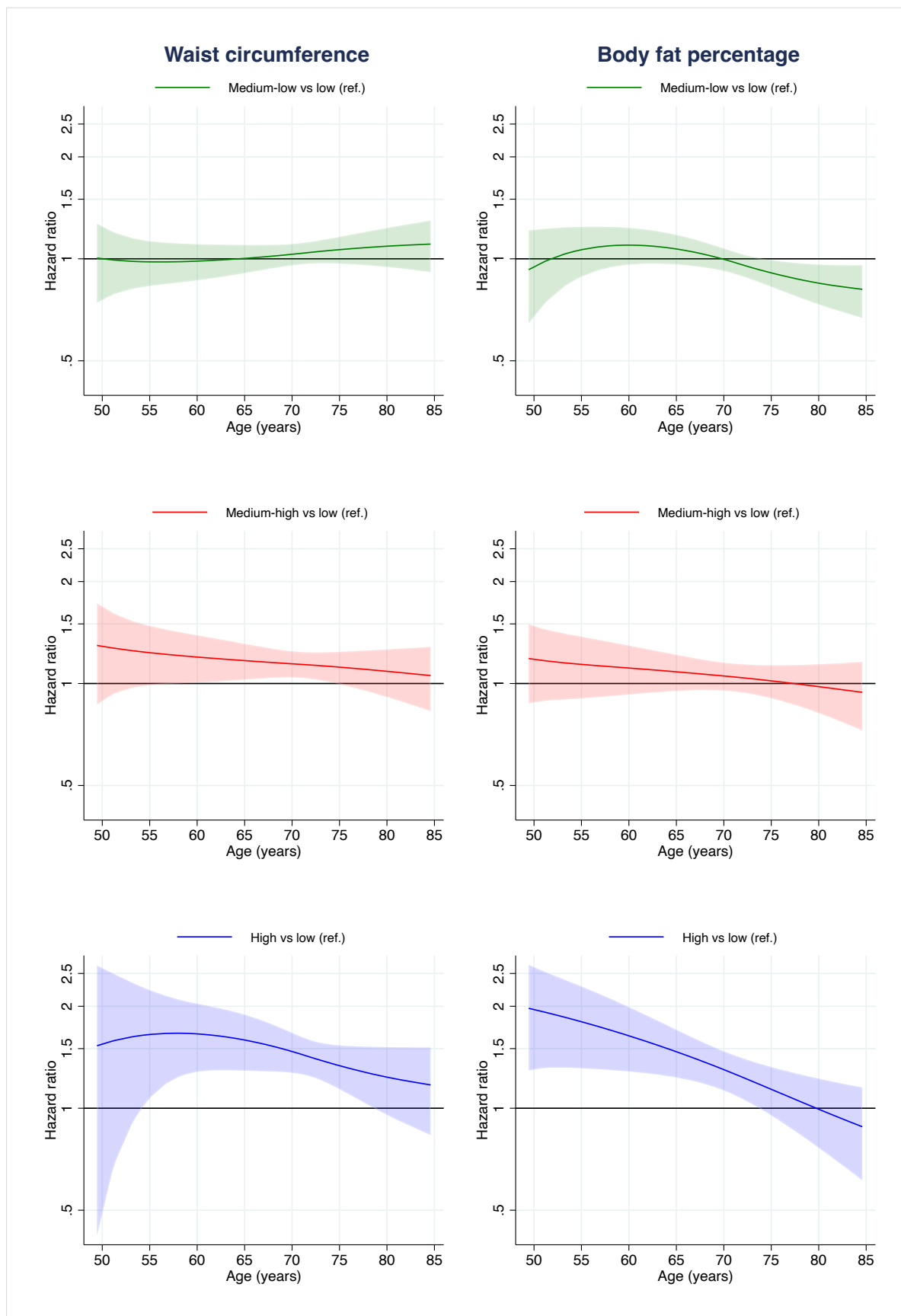
Supplementary Figure 3. All-cause mortality hazard ratio's variations across age by categories of waist circumference-body mass index residuals and body fat percentage. Results adjusted for age (as time-scale), sex, ethnicity, education, living/not living with partner, employment, diet pattern, salt consumption, screen time, smoking, alcohol consumption, depression, Townsend Index and weekly physical activity. The model for body fat percentage was also adjusted by the Lean Mass Index.



Supplementary Figure 4. All-cause mortality hazard ratio's variations across age across categories of Body Mass Index, Fat Mass Index, Lean Mass Index, waist circumference and body fat percentage, stratified for women (n=200,201) and men (n=169,551). Results adjusted for age (as time-scale), ethnicity, education, living/not living with partner, employment, diet pattern, salt consumption, screen time, smoking, alcohol consumption, depression, Townsend Index and weekly physical activity. Fat Mass Index and Body fat percentage were adjusted for Lean Mass Index, which was adjusted for Fat Mass Index. BFP: body fat percentage; BMI: body mass index; FMI: fat mass index; LMI: lean mass index; Ref: reference; WC: waist circumference.



Supplementary Figure 5. All-cause mortality hazard ratios' variations across age and categories of waist circumference and body fat percentage, in never smokers (n=212,071). Results adjusted for age (as time-scale), sex, ethnicity, education, living/not living with partner, employment, diet pattern, salt consumption, screen time, alcohol consumption, depression, Townsend Index and weekly physical activity. The model for body fat percentage was also adjusted by the Lean Mass Index.



Supplementary Figure 6. All-cause mortality hazard ratios's variations across age and categories of Body Mass Index, Fat Mass Index, Lean Mass Index, waist circumference and body fat percentage, in people who reported no weight change in previous year to the baseline assessment (n=210,872). Results adjusted for age (as time-scale), sex, ethnicity, education, living/not living with partner, employment, diet pattern, salt consumption, screen time, smoking, alcohol consumption, depression, Townsend Index and weekly physical activity. Fat Mass Index and body fat percentage were adjusted for Lean Mass Index, which was adjusted for Fat Mass Index.

