Supporting Information

Leisure-time Physical Activity and Life Expectancy in people with Cardiometabolic Multimorbidity and Depression

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Table S1: Previous studies investigating leisure-time exercise and life expectancy

Authors	Year	Country	No. of individuals, average follow-up	Age at start of follow-up	Population	Leisure-time exercise types, meeting recommended levels?
Janssen et al.[1]	2013	U.S.	95358, 9 years	20 years	General, Hispanic and non-Hispanic	Walking or cycling, moderate intensity and vigorous intensity sports, fitness or recreational activities. Mentions the recommended levels.
Moore et al.[2]	2012	U.S.	654827, 10 years (pooled analysis of 6 studies)	40 years	General	Walking, jogging /running, swimming, tennis/racquetball, bicycling, aerobics, and dance. Mentions the recommended levels.
Wen et al.[3]	2011	Taiwan	416175, 8 years	30 years	General	Light, moderate and vigorous exercises, e.g. walking, brisk walking, running. Mentions the recommended levels.
Byberg et al. [4]	2009	Sweden	2205, 35 years	50 years	General, males only	Survey questions based on sedentary activities, walking, cycling, engaging in active recreational sports, or hard physical training or competitive sport.
Schnohr et al.[5]	2018	Denmark	8577, 25 years	20 years	General	The specific sports studied were tennis, badminton, soccer, jogging, cycling, calisthenics, swimming, and health club activities, compared with sedentary lifestyle.

A PubMed and Google Scholar search was carried out with the terms "leisure-time", "exercise", "physical activity", and "life expectancy" on 25th June 2019. In the table we reported the studies we deemed most relevant.

References

1 Janssen I, Carson V, Lee IM, Katzmarzyk PT, Blair SN. Years of life gained due to leisure-time physical activity in the U.S. *Am J Prev Med* 2013; **44:** 23-9.

2 Moore SC, Patel AV, Matthews CE*, et al.* Leisure time physical activity of moderate to vigorous intensity and mortality: a large pooled cohort analysis. *PLoS medicine* 2012; **9:** e1001335.

3 Wen CP, Wai JP, Tsai MK*, et al.* Minimum amount of physical activity for reduced mortality and extended life expectancy: a prospective cohort study. *Lancet* 2011; **378:** 1244-53.

4 Byberg L, Melhus H, Gedeborg R*, et al.* Total mortality after changes in leisure time physical activity in 50 year old men: 35 year follow-up of population based cohort. *Bmj* 2009; **338:** b688.

5 Schnohr P, O'Keefe JH, Holtermann A, Lavie CJ, Lange P, Jensen GB, Marott JL. Various Leisure-Time Physical Activities Associated With Widely Divergent Life Expectancies: The Copenhagen City Heart Study. *Mayo Clinic Proceedings*: Elsevier. 2018; 1775-85.

Figure S1: Flow chart of participants included in the study

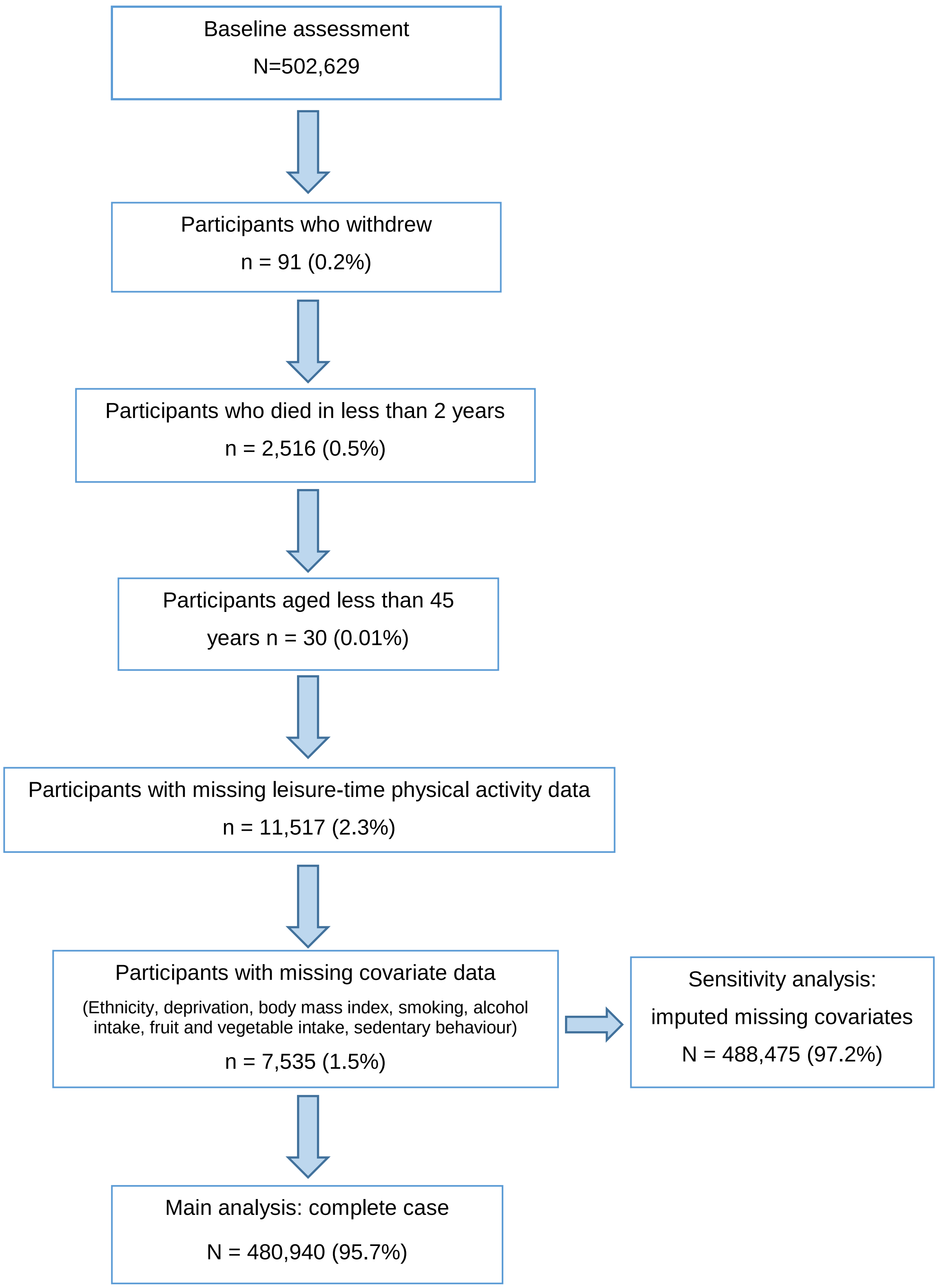


Table S2: UK Biobank variable data-field used in this study

Variable name	Data Field
Non-cancer illness code, self-reported	20002
Diabetes*	1220
Stroke*	4056
Myocardial infarction*	1075
Heart failure*	1076
Angina*	1074
Peripheral vascular disease*	1067
Depression*	1286
Anxiety*	1287
Types of physical activity in last 4 weeks	6164
Frequency of walking for pleasure	971
Duration walking for pleasure	981
Frequency of strenuous sports	991
Duration of strenuous sports	1001
Frequency of light DIY	1011
Duration of light DIY	1021
Frequency of heavy DIY	2624
Duration of heavy DIY	2634
Frequency of other exercises	3637
Duration of other exercises	3647
Cancer	20001
Sex	31
Ethnicity	21000
Socioeconomic status	189
Employment status	6142
Body mass index	21001
Smoking status	20116
Alcohol intake	1588, 1578, 1608, 5364, 1568, 1598
Fruit and vegetable intake	1309, 1319, 1289, 1299
Sedentary behaviour	1070, 1080, 1090

* Codes for conditions were identified in data field 20002.
DIY=do-it-yourself leisure-time activities.

Methods S1: Additional methods for sociodemographic and lifestyle factors

Ethnicity
Ethnicity was categorised as white or non-white.

Socioeconomic status
Townsend deprivation index was used as a measure of socioeconomic status. This measure combines census data on housing, employment, social class, and car availability based on the postal code of participants. The Townsend deprivation index has been validated for use in a UK-based population.[1] The index was categorised into two groups: the least deprived and the most deprived based on sample population.

Employment status
Employment status was grouped as working (in paid employment or self-employed), retired, or other (unemployed, looking after home and/or family, unable to work because of sickness or disability, doing unpaid or voluntary work, full or part time student, or did not provide an answer). The first entered employment was assumed as the most current employment status.

Body Mass Index
Body mass index (BMI) value was calculated from the height (cm) and weight (kg) measured during the physical assessments (weight in kg divided by the square of the height in metres).

Smoking
Participants were asked about their smoking status during the assessment; responses were categorised as current, previous, never smoked.

Alcohol
The UK Biobank asked participants for the number of pints of beer, glasses of wine, and measures of spirit consumed in the last week. Alcoholic drinks differ in the amount of alcohol content, therefore each drink was converted into equivalent standard units, where 1 unit contained 10 ml of ethyl alcohol.[2] The guidelines from the Office for National Statistics (ONS) were used as this was the most updated method of converting volumes to units.[2] Total weekly units of alcohol were calculated by adding the units of beer, wine, and spirits. Excess alcohol consumption was defined as more than 14 units of alcohol a week based on the NHS guidelines.[3]

Fruit and vegetable intake
To calculate the fruit and vegetable intake, the combined responses for fresh fruit (pieces), dried fruit (pieces), salad/raw vegetable (heaped tablespoons), and cooked vegetable (heaped tablespoons), were converted into proportions and based on the NHS guidelines[4] we grouped participants as <5 portions/day (does not meet fruit/vegetable guidelines) or ≥5 portions/day (meet fruit/vegetable guidelines).

Sedentary behaviour
To measure the total sedentary time, the sum of self-reported hours spent watching television, using the computer, and driving were derived on a typical day. Values greater than 24 hours per day were excluded, and those reporting over 16 hours were re-coded to 16 hours.

References
1 Townsend P. Poverty in the United Kingdom London: Allen Lane and Penguin Books'. 1979.
2 Goddard E. *Estimating alcohol consumption from survey data: updated method of converting volumes to units*. Office for National Statistics Newport. 2007.
3 Alcohol units. NHS Choices, 2015. Accessed May 10, 2019, avaiable at https://www.nhs.uk/Livewell/alcohol/Pages/alcohol-units.aspx.
4 5 A Day portion sizes. NHS Choices. Accessed May 1, 2019, avaiable at http://www.nhs.uk/Livewell/5ADAY/Pages/Portionsizes.aspx.

Methods S2: Missing covariate data

Missing covariates (n=7,535) were imputed using a single imputation approach. Imputing missing data ensured our main findings were consistent as the imputed data increased statistical power and minimised bias in the presence of confounding variables. The single imputation method was chosen over the multiple imputation, since we were unable to process survival curves required for the life expectancy calculations due to the computational time using an extremely large database. We replaced the missing values using the observed data. This information was taken from participants with complete data where the modal value was used to impute categorical data and the mean value was used to impute continuous data. Table A presents the number and percentage missing, the method and the value that was imputed.

Table A Missing covariate data

Characteristics	**No. missing (%)**	**Imputation method**	**Value imputed**
Ethnicity	1,684 (0.3)	Mode	White
Deprivation	608 (0.1)	Mode	Least deprived
Body mass index	2,265 (0.5)	Mean	27.40477 kg/m^2
Smoking Status	1,768 (0.4)	Mode	Never
Alcohol status	612 (0.1)	Mode	Never or <14 units/wk
Meet fruit/vegetable guidelines (5/days)	555 (0.1)	Mode	No
Sedentary behaviour	459 (0.1)	Mean	5.0 hours

% calculated from the total number of participants (n=488,475), participants may had more than one missing covariates.

Table S3: All-cause mortality by baseline disease status and leisure-time physical activity group, active vs inactive, following imputation of missing data (n=488,475)

	Disease status at baseline							
	None	Diabetes	CVD	Depression	Diabetes + CVD	Diabetes + Depression	CVD + Depression	Diabetes + CVD + Depression
Inactive (234,410 participants)								
No. participants (%)	195,945 (46.6)	9,133 (52.0)	11,363 (52.0)	13,591 (56.1)	2,301 (63.6)	721 (69.1)	1,129 (67.7)	227 (73.9)
No. deaths (%)	4,309 (2.2)	477 (5.2)	752 (6.6)	330 (2.4)	285 (12.4)	38 (5.3)	94 (8.3)	33 (14.5)
Mortality rate (95% CI) , 1000 py	3.15 (3.06, 3.25)	7.62 (7.00, 8.34)	9.57 (8.91, 10.28)	3.48 (3.12, 3.88)	18.31 (16.30, 20.56)	7.63 (5.55, 10.48)	12.03 (9.82, 14.72)	21.51 (15.29, 30.26)
Active (254,065 participants)								
No. participants (%)	224,221 (53.4)	6,461 (41.4)	10,485 (48.0)	10,641 (43.9)	1,317 (36.4)	322 (30.8)	538 (32.3)	80 (26.1)
No. deaths (%)	3,858 (1.7)	256 (4.0)	495 (4.7)	207 (2.0)	125 (9.5)	17 (5.3)	28 (5.2)	7 (8.8)
Mortality rate (95% CI) , 1000 py	2.47 (2.39, 2.55)	5.74 (5.08, 6.49)	6.80 (6.22, 7.42)	2.78 (2.43, 3.18)	13.91 (11.68, 16.58)	7.62 (4.73, 12.25)	7.44 (5.14, 10.78)	12.70 (6.06, 26.65)
Hazard ratio for all-cause mortality (95% CI), active vs inactive								
Model 1	0.75 (0.72, 0.78)	0.72 (0.62, 0.84)	0.67 (0.60, 0.75)	0.77 (0.65, 0.92)	0.71 (0.57, 0.87)	0.88 (0.50, 1.57)	0.58 (0.38, 0.89)	0.54 (0.24, 1.22)
Model 2	0.73 (0.70, 0.77)	0.71 (0.60, 0.82)	0.67 (0.59, 0.75)	0.80 (0.67, 0.96)	0.72 (0.58, 0.90)	0.75 (0.42, 1.36)	0.59 (0.38, 0.91)	0.55 (0.24, 1.27)
Model 3	0.78 (0.75, 0.82)	0.76 (0.64, 0.89)	0.72 (0.64, 0.81)	0.86 (0.72, 1.03)	0.77 (0.62, 0.95)	0.80 (0.44, 1.47)	0.68 (0.44, 1.04)	0.48 (0.20, 1.15)
Years of life gained at the age of 45 years (95% CI), active vs inactive								
Model 1	2.08 (1.75, 2.41)	2.95 (1.54, 4.36)	3.53 (2.46, 4.59)	1.99 (0.64, 3.34)	3.73 (1.25, 6.20)	1.20 (-4.32, 6.71)	5.17 (0.83, 9.51)	6.52 (-3.00, 16.03)
Model 2	2.12 (1.81, 2.43)	2.93 (1.60, 4.26)	3.04 (2.13, 3.94)	1.55 (0.31, 2.80)	2.95 (0.81, 5.10)	2.25 (-2.44, 6.95)	4.23 (-0.56, 9.03)	5.16 (-2.33, 12.65)
Model 3	1.62 (1.31, 1.93)	2.22 (0.93, 3.51)	2.35 (1.47, 3.22)	1.04 (-0.21, 2.28)	2.35 (0.29, 4.41)	1.88 (-3.22, 6.98)	2.85 (-0.71, 6.41)	6.21 (-1.65, 14.07)
Years of life gained at the age of 65 years (95% CI), active vs inactive								
Model 1	1.88 (1.58, 2.18)	2.40 (1.24, 3.56)	3.01 (2.10, 3.92)	1.73 (0.55, 2.91)	2.89 (0.96, 4.83)	0.96 (-3.48, 5.39)	4.27 (0.64, 7.89)	5.15 (-2.50, 12.80)
Model 2	1.89 (1.61, 2.17)	2.38 (1.29, 3.47)	2.60 (1.83, 3.38)	1.35 (0.26, 2.44)	2.41 (0.64, 4.18)	1.74 (-1.96, 5.43)	3.68 (-0.61, 7.98)	4.03 (-1.92, 9.99)
Model 3	1.44 (1.17, 1.72)	1.82 (0.76, 2.89)	2.03 (1.27, 2.78)	0.91 (-0.19, 2.01)	1.93 (0.23, 3.64)	1.44 (-2.50, 5.38)	2.52 (-0.65, 5.69)	4.67 (-1.27, 10.60)

CVD=cardiovascular disease [stroke (4,859), myocardial infarction (8,564), heart failure (203), angina (11,748), peripheral vascular disease (767); sum is greater than 488,475 as participants may have more than one CVD]; Inactive <500 METs-minutes/week; Active ≥500 METs-minutes/week; CI=confidence interval; py=person years.

% No. participants = total no. of participants in each group / total no. participants

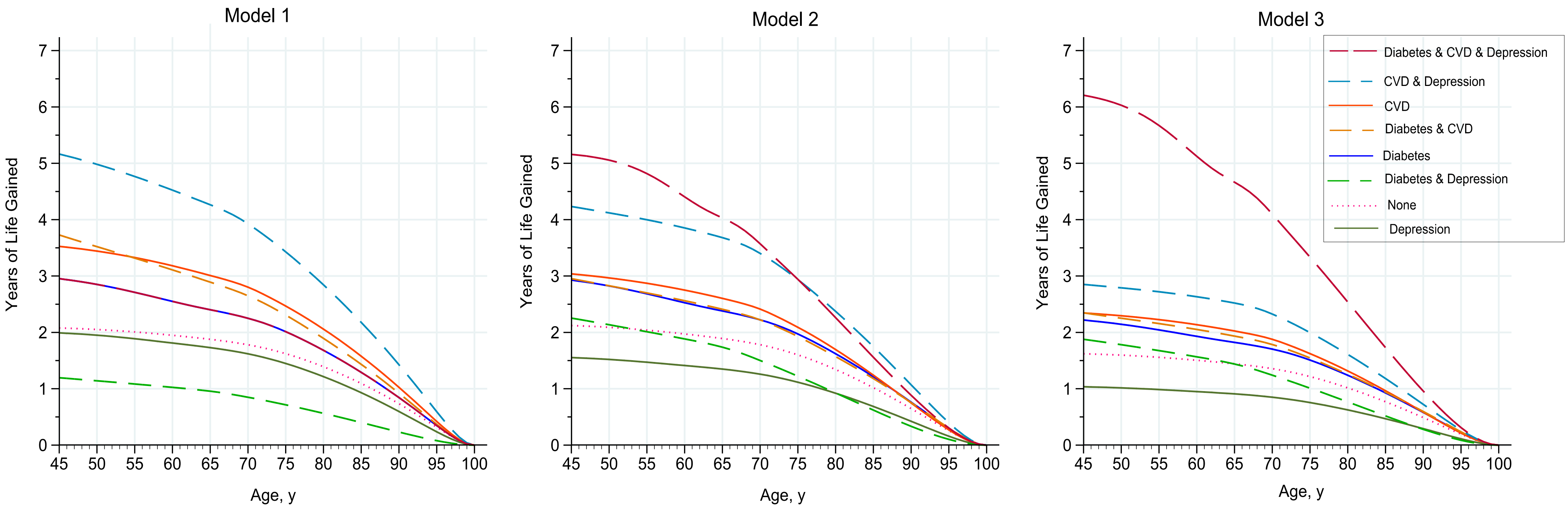
% No. deaths= total no. of deaths in each group / total no. participants in each group

Model 1: unadjusted.

Model 2: adjusted for cancer + sociodemographic factors [sex (male, female), ethnicity (white, non-white), socioeconomic status (most or least deprived), and employment status (working, retired, other)].

Model 3: Model 2 + lifestyle factors [body mass index, smoking status (never, previous, current), alcohol intake (less than or more than 14 units/wk), meet fruit and vegetable intake (yes, no), and sedentary behaviour].

Figure S2: Years of life gained by baseline disease status and leisure-time physical activity group, active vs inactive, following imputation of missing data



CVD=cardiovascular disease [stroke, myocardial infarction, heart failure, angina, peripheral vascular disease]; Inactive <500 METs-minutes/week; Active ≥500 METs- minutes/week; y=years.

Years of life gained were calculated as the difference in residual life expectancy between active and inactive participants.

Model 1: unadjusted.

Model 2: adjusted for cancer + sociodemographic factors [sex (male, female), ethnicity (white, non-white), socioeconomic status (most or least deprived), and employment status (working, retired, other)].

Model 3: Model 2 + lifestyle factors [body mass index, smoking status (never, previous, current), alcohol intake (less than or more than 14 units/wk), meet fruit and vegetable intake (yes, no), and sedentary behaviour].