### Supplementary material S1: Methodological details

#### Literature Search

One author (DM) searched four databases (PubMed, PsycINFO, Embase and Web of Science) from database inception to 28 February 2018 using the following search terms:

""sedentary"" OR ""sedentari\*"" OR ""sedentary behavio\*"" OR ""sedentary lifestyle"" OR ""sedentary"" OR ""sitting"" OR ""sitting time"" OR ""physical inactivity"" OR ""inactivity\*"" OR ""physically inactive""

AND ""physical activity"" OR ""physical activities"" OR ""physically active"" OR ""physical exercise"" OR ""exercise\*"" OR ""walk\*""

AND ""mortality"" OR ""mortalities"" OR ""death"" OR ""fatal""

The systematic search retrieved 1,903 articles of which 149 papers for full text were screened, and 12 studies were identified as eligible for inclusion based on content of the paper and personal knowledge of the studies. The list of 12 was reviewed and confirmed by a second co-author (SC). Of these studies, six studies did not respond to our request or declined to participate (due to lack of time and resources), two studies' data was publicly available, and 4 studies agreed to participate. These 6 studies were included in the pooled analysis (Table 1). One further study suitable for inclusion was discovered to have been omitted after the conclusion of the federated analysis.

# Accelerometry processing

Accelerometer data were processed by each local study with inclusion as per Table A4. Codes for processing are available on request or can be found on GitHub <a href="https://github.com/wadpac/code-published-studies/tree/master/WH2">https://github.com/wadpac/code-published-studies/tree/master/WH2</a> McGregor

## **Accelerometer Thresholds**

A variety of devices and protocols were used in the individual studies. Details of these are provided in Table A1.

Study	Device (location)	Data Used	Threshold for inclusion of individual	SB	LIPA	MVPA
ABC	Actigraph 7164	Uniaxial;	At least one	0 – 99	100 - 2019	2020+
	(lower back)	1 minute epoch	valid day with 10+ hours of	cpm	cpm	cpm
		1	wear time			
NHANES	Actigraph 7164	Uniaxial;	At least one	0 - 99	100 - 2019	2020+
2003-06	(right hip)	1 minute	valid day with	cpm	cpm	cpm
		epoch	10+ hours of wear time			
REGARDS	Actical	Uniaxial;	At least four	0 - 49	50 - 1065	1065+
	(right hip)	1 minute	valid days with	cpm	cpm	cpm
		epoch	10+ hours of wear time / day			
UK Biobank	Axivity AX3	Triaxial;	At least 72	0 - 39	40 - 99	100+
	(dominant wrist)	5 seconds	hours total wear	mg	mg	mg
		epoch	time and wear			
			data in each			
			one-hour period			
			of the 24-hour			
			cycle			

Whitehall II	GENEActiv	Triaxial;	Daily wear time	0 - 39	40 – 99	100+
	Original (non-	Bout	≥2/3 of waking	mg	mg	mg
	dominant wrist)	based	hours, for at			
		algorithm	least 2			
		based on	weekdays and 2			
		5 seconds	week-end days.			
		epoch				
Women's	ActiGraph	Triaxial;	At least four	0 - 199	200 - 2689	2690+
Health Study	GT3X+ (hip -	1 minute	valid day with	cpm	cpm	cpm
	unspecified)	epoch	10+ hours of			
			wear time / day			

 ${\bf Table\ A1\ Details\ of\ individual\ study's\ physical\ activity\ data\ collection\ protocols.}$ 

#### **Causal Assumptions**

Selection of these covariates was based on the causal assumptions represented as a directed acyclic graph (DAG) below (Figure S1).

Our analysis was guided by the work of Arnold et al [1] on causal inference for compositional data and the recent review about the causal link between physical activity and longevity by Kujala [2]. Arnold et al have introduced DAG notation which are specific to causal inference for compositional data and their interpretation. In a DAG compositional variables are represented in a dashed box indicating that those variables occur at an instantaneous point in time. The composition, here the movement behaviour time composition, is fully determined by the sum of the parts. The deterministic relationship between variables representing the parts and the composition are indicated by double-lined arrow. In the case of compositional data, two distinct causal effect estimation need to be considered the total ('unconditional') effect of the composition on the outcome and the relative ('collider-conditional') effect. The latter is indicated in the DAG by dashed arrows and represents a joint effect of the balance between parts. For compositional data with fixed totals, which is the case of movement behaviours as the day is constrained to 24 hours, only the relative joint effect can be identified.

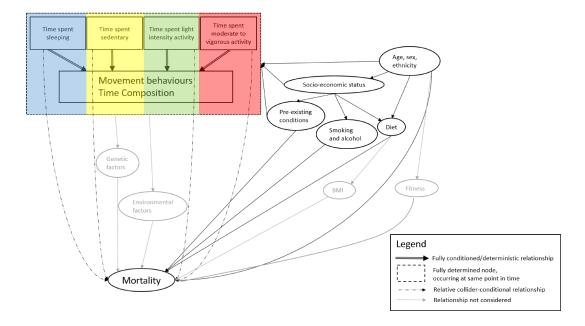


Figure A1: Directed acyclic graph illustrating the causal assumption of this study. Some relationships between factors have been omitted for clarity.

### **Summary results**

The raw coefficients from the compositional Cox regression model are set out by study in Table A2. The sign of the coefficient indicates the sign of the association of the mortality outcome with the ilr-coordinate. "NA" indicates that sleep time was not available in the study.

Figure A2 below shows the compositional centres and density contour of compositions within the included studies. This shows the data coverage and the dispersion of compositions. Two clear cluster exist representing wrist and hip accelerometer data.

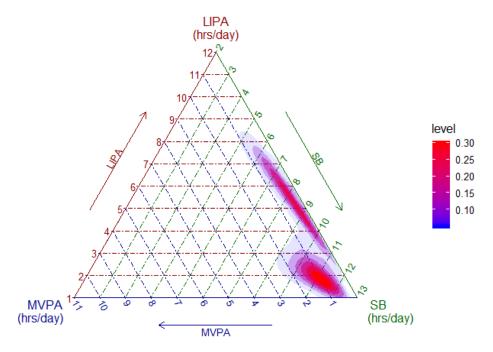


Figure A2: Density plot of waking day compositions, re-weighted to give equal probability weight to each study based on NHANES and UK Biobank data supplemented with synthetic data simulated based on summary statistics of the remaining studies and the additive logistic normal distribution.

Study	$z_1$	$\mathbf{z}_2$	$z_3$
REGARDS	NA	-0.1461*	-0.5021*
ABC	NA	-0.0645	-0.7527*
Whitehall II	-0.2488	-0.4894*	-0.2779
UK Biobank	-0.0643	-0.4248*	0.1091
NHANES 03-06	NA	-0.0877	-0.5238*
Woman's Health Study	NA	-0.0244*	-0.7667*

<sup>\*</sup> Statistically significant at 5% significance level based on Wald test statistic.

Table A2: Summary Cox regression coefficient estimates by individual study.