SUPPLEMENTAL MATERIAL
### Table S1. Baseline characteristics of the participants in the study by categories based on the 10th, 50th, and 90th percentiles of accelerometer-measured moderate-to-vigorous physical activity distribution (n=39,294).

| Variable                        | Total     | <342.72 min/day | 342.72 - <675.36 min/day | 675.36 - <1139.04 min/day | ≥ 1139.04 min/day | p-value |
|---------------------------------|-----------|-----------------|--------------------------|---------------------------|------------------|---------|
| Number                          | 39294     | 4067            | 15739                    | 15589                     | 3899             |         |
| Sedentary behaviour (min/week)  | 4994.02 (676.76) | 5749.63 (565.47) | 5249.43 (525.76) | 4749.78 (518.95) | 4151.41 (531.41) | <0.001 |
| MVPA (min/week)                 | 716.56 (320.88) | 254.84 (69.39)  | 524.64 (92.66)          | 868.87 (126.91)          | 1363.94 (225.11) | <0.001 |
| Total volume of PA (mg)         | 40.50 (12.52) | 23.55 (4.28)    | 33.74 (4.97)            | 46.09 (7.23)             | 63.08 (11.57)    | <0.001 |
| Sleep patterns* (%)            |           |                 |                          |                           |                  | <0.001 |
| Poor                            | 916 (2.3)  | 371 (2.4)       | 297 (1.9)                | 56 (1.4)                  | 192 (4.7)        |         |
| Intermediate                    | 15437 (39.3) | 6536 (41.5)     | 5653 (36.3)             | 1341 (34.4)               | 1907 (46.9)      |         |
| Healthy                         | 22941 (58.4) | 8832 (56.1)     | 9639 (61.8)             | 2502 (64.2)               | 1968 (48.4)      |         |
| Age (years)                     | 58.39 (7.13) | 61.81 (5.83)    | 59.35 (6.82)            | 57.30 (7.18)              | 55.25 (7.27)     | <0.001 |
| Sex = male (%)                  | 19857 (50.5) | 2196 (54.0)     | 8179 (52.0)             | 1907 (46.9)               | 1779 (45.6)      | <0.001 |
| Obesity† = yes (%)              | 10454 (26.6) | 1796 (44.2)     | 4891 (31.1)             | 3224 (20.7)               | 543 (13.9)       | <0.001 |
| Education = university/college (%) | 23878 (60.8) | 2654 (65.3)     | 9544 (60.6)             | 9273 (59.5)               | 2407 (61.7)      | 0.001  |
| Smoking (%)                     |            |                 |                          |                           |                  | <0.001 |
| Never                           | 21230 (54.0) | 1962 (48.2)     | 8452 (53.7)             | 8643 (55.4)               | 2173 (55.7)      |         |
| Previous                        | 15582 (39.7) | 1692 (41.6)     | 6263 (39.8)             | 6103 (39.1)               | 1524 (39.1)      |         |
| Current                         | 2482 (6.3)  | 413 (10.2)      | 1024 (6.5)              | 843 (5.4)                 | 202 (5.2)        |         |
| Diet score‡ (%)                 |            |                 |                          |                           |                  | <0.001 |
| Poor                            | 9650 (25.0) | 795 (20.0)      | 3739 (24.1)             | 3996 (26.0)               | 1120 (29.3)      |         |
| Reasonable                      | 2142 (5.5)  | 295 (7.4)       | 902 (5.8)               | 768 (5.0)                 | 177 (4.6)        |         |
| Good                            | 26850 (69.5) | 2885 (72.6)     | 10847 (70.0)            | 10594 (69.0)              | 2524 (66.1)      |         |
| Alcohol use§ (%)                |            |                 |                          |                           |                  | <0.001 |
| Never                           | 1104 (2.8)  | 162 (4.0)       | 451 (2.9)               | 401 (2.6)                 | 90 (2.3)         |         |
| Previous                        | 1054 (2.7)  | 170 (4.2)       | 437 (2.8)               | 353 (2.3)                 | 94 (2.4)         |         |
| Occasional                      | 7457 (19.0) | 1049 (25.8)     | 3089 (19.6)             | 2631 (16.9)               | 688 (17.6)       |         |
| Within guidelines               | 13264 (33.8) | 1187 (29.2)     | 5425 (34.5)             | 5375 (34.5)               | 1277 (32.8)      |         |
| Double guidelines               | 9530 (24.3) | 845 (20.8)      | 3709 (23.6)             | 3971 (25.5)               | 1005 (25.8)      |         |
| Above double guidelines         | 6885 (17.5) | 654 (16.1)      | 2628 (16.7)             | 2858 (18.3)               | 745 (19.1)       |         |
| HbA1c (mmol/mol)                | 36.21 (9.2)  | 38.32 (8.22)    | 36.53 (6.68)            | 35.58 (5.24)              | 35.22 (4.77)     | <0.001 |
| Pre-existing CVD = yes (%)      | 13686 (34.8) | 2119 (52.1)     | 5967 (37.9)             | 4657 (29.9)               | 943 (24.2)       | <0.001 |
| Hypertension medication = yes (%) | 12938 (32.9) | 1877 (47.8)     | 2030 (49.9)             | 5800 (36.9)               | 4302 (27.6)      | <0.001 |
| Mean Arterial                   | 109.06 (10.19) | 108.18          | 109.09                  | 109.23                    | 109.16           | <0.001 |
Pressure (mmHg) | (11.32) | (10.37) | (9.78) | (9.76) | <0.001
---|---|---|---|---|---
Diastolic Blood Pressure (mmHg) | 87.61 (9.79) | 86.47 (10.56) | 87.59 (9.91) | 87.86 (9.52) | 87.82 (9.40)
Systolic Blood Pressure (mmHg) | 151.96 (16.24) | 151.60 (18.02) | 152.07 (16.50) | 151.98 (15.62) | 151.82 (15.70) | 0.412

Values represent Mean (SD) unless specified otherwise.

MVPA, moderate-to-vigorous physical activity.

* Participants were categorized by how many healthy sleep characteristics (morning chronotype, adequate sleep duration (7-8 hr./d), never or rare insomnia, never or rare snoring, and infrequent daytime sleepiness) they displayed into three groups (healthy: ≥ 4; intermediate: 2-3; poor: ≤ 1).† Obesity was ascertained based on body mass index, BMI (i.e., participants with a BMI ≥30 were considered obese).

‡ Dietary intake was collected using a touchscreen questionnaire that collected information on food frequency consumption. Dietary pattern was classified based on the UK’s latest-available National Health Service Eatwell Guide and a previously applied scoring procedure that considered consumption of fruits, vegetables, fish, red meats (unprocessed), and processed meats. One point was awarded for each of the following conditions that were met in each participant’s diet, with possible scores ranging from 0 to 4 points: total fruit and vegetable intake ≥ 4.5 pieces or servings/day (one serving of vegetables was considered to be 3 tablespoons of vegetables); total fish intake ≥ 2 times/week; red meat (unprocessed) intake ≤ 5 times/week; processed meat intake ≤ 2 times/week. Diets were categorised as poor (0), reasonable (1), and good (2-4).

§ Guidelines for alcohol use in the UK recommend no more than 14 units of alcohol per week for both men and women.

|| One-way ANOVA for continuous variables and Chi Square Test for categorical variables
## Table S2. STROBE checklist.

| Section and Item       | Item No. | Recommendation                                                                 | Reported on Page No. |
|------------------------|----------|--------------------------------------------------------------------------------|----------------------|
| **Title and Abstract** | 1        | *(a) Indicate the study’s design with a commonly used term in the title or the abstract* | 1                    |
|                        |          | *(b) Provide in the abstract an informative and balanced summary of what was done and what was found* | 2                    |
| **Introduction**       | 2        | Explain the scientific background and rationale for the investigation being reported | 3                    |
| **Objectives**         | 3        | State specific objectives, including any prespecified hypotheses                  | 3                    |
| **Methods**            | 4        | Present key elements of study design early in the paper                           | 3, 4                 |
| Study Design           | 5        | Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection | 3, 4                 |
| Setting                | 6        | *(a) Cohort study—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up* | 3, 4                 |
|                        |          | *Case-control study—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls* | NA                  |
|                        |          | *Cross-sectional study—Give the eligibility criteria, and the sources and methods of selection of participants* | NA                  |
|                        |          | *(b) Cohort study—For matched studies, give matching criteria and number of exposed and unexposed* | NA                  |
|                        |          | *Case-control study—For matched studies, give matching criteria and the number of controls per case* | NA                  |
| Variables                                      | 7 | Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable | 3-5 |
|------------------------------------------------|---|-------------------------------------------------------------------------------------------------------------------------------|-----|

| Section and Item                              | Item No. | Recommendation                                                                                                                                                                                                 | Reported on |
|------------------------------------------------|-----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| 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                                                                 | 3-5          |
| Bias                                           | 9         | Describe any efforts to address potential sources of bias                                                                                                                                                     | 5,6          |
| Study Size                                     | 10        | Explain how the study size was arrived at                                                                                                                                                                     | 3,4          |
| Quantitative Variables                         | 11        | Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why                                                                                  | 3-5          |
| Statistical Methods                            | 12        | (a) Describe all statistical methods, including those used to control for confounding                                                                                                                                          | 5,6          |
|                                                |           | (b) Describe any methods used to examine subgroups and interactions                                                                                                                                              | 5,6          |
|                                                |           | (c) Explain how missing data were addressed                                                                                                                                                                     | NA           |
|                                                |           | (d) Cohort study—If applicable, explain how loss to follow-up was addressed                                                                                                                                     | NA           |
|                                                |           | Case-control study—If applicable, explain how matching of cases and controls was addressed                                                                                                                       | NA           |
|                                                |           | Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy                                                                                                             | NA           |
|                                                |           | (e) Describe any sensitivity analyses                                                                                                                                                                          | 5,6          |

| Results                                        | 13*       | (a) Report numbers of individuals at each stage—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed | Supplementa l Figure 1; 3,4 |
|                                                |           | (b) Give reasons for non-participation at each stage                                                                                                                                                           | Supplementa l Figure 1; 3,4 |
| Section and Item   | Item No. | Recommendation                                                                 | Reported on Page No. |
|-------------------|----------|-------------------------------------------------------------------------------|----------------------|
| **Main Results**  | 16       | *(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates* and their precision (e.g., 95% confidence interval). Make clear which confounders were adjusted for and why they were included | Figures 1-4; 5,6     |
|                   |          | *(b) Report category boundaries when continuous variables were categorized*     | 4-6                  |
|                   |          | *(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—e.g., analyses of subgroups and interactions, and sensitivity analyses | 6.7; Sup Figures 3-8 |

**Discussion**

| Item               | Recommendation                                                                                   | Page No. |
|--------------------|-------------------------------------------------------------------------------------------------|----------|
| Key Results        | Summarise key results with reference to study objectives                                          | 7        |
| Limitations        | Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias | 8-9      |
| Interpretation     | Give a cautious overall interpretation of results considering objectives, limitations,           | 7-9      |
| Generalisability | 21 | Discuss the generalisability (external validity) of the study results |
|------------------|----|------------------------------------------------------------------|

**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 |
|------------------|----|------------------------------------------------------------------|
Figure S1. DAG diagram of included covariates in the study.

We used an online software package to generate this figure from Dagitty.net. SES, social economical status; CVD, cardiovascular disease
Figure S2. Flow diagram of participants in the study.

Participants in the UKBB (n=502,547)

Participants with accelerometer data (n=103,684)

Participants with valid accelerometer data (n=96460)

Participants with valid accelerometer data and hypertension at baseline (n=47472)

Participants with valid accelerometer data, hypertension at baseline, and who had complete data on covariates (mortality outcomes analysis) (n=39294)

Participants without prevalent CVD (CVD incidence analysis) (n=31968)  
Participants without prevalent stroke (stroke incidence analysis) (n=38978)  
Participants without prevalent CHD (CHD incidence analysis) (n=36669)
Figure S3. Dose–response association (Adjusted* hazard ratios and associated 95% confidence interval band) between accelerometer-measured moderate-to-vigorous physical activity and total volume of physical activity with stroke (n=39294; events=93) and CHD (n=39294; events=251) mortality.

* Adjusted for age, sex, education, sedentary behaviour (only models for moderate-to-vigorous physical activity), sleep pattern, obesity, smoking, and alcohol use. CVD, cardiovascular disease. Dose-response associations were assessed with restricted cubic splines with knots at 10th, 50th, and 90th centiles of the distribution of the exposure of interest (reference category = 675.36 minutes/week of moderate-to-vigorous physical activity; and 39.04 milligravities (mg) for total volume of physical activity). Hazard ratios are in logarithmic scale.
Figure S4. Dose–response association (Adjusted* hazard ratios and associated 95% confidence interval band) between accelerometer-measured moderate-to-vigorous physical activity and total volume of physical activity with incidence of stroke (n=38978; events=527) and CHD (n=36669; events=1493).

* Adjusted for age, sex, education, sedentary behaviour (only models for moderate-to-vigorous physical activity), sleep pattern, obesity, smoking, and alcohol use. CHD, coronary heart disease. Dose-response associations were assessed with restricted cubic splines with knots at 10th, 50th, and 90th centiles of the distribution of the exposure of interest (reference category = 675.36 and 685.44 minutes/week of moderate-to-vigorous physical activity for stroke and CHD respectively; and 39.09 and 39.38 milligravities (mg) for total volume of physical activity for stroke and CHD respectively). Hazard ratios are in logarithmic scale.
Figure S5. Dose–response association (Adjusted* hazard ratios and associated 95% confidence interval band) between accelerometer-measured moderate-to-vigorous physical activity and total volume of physical activity with all-cause (n=38977; events=12201), CVD mortality (n=38977; events=430), and CVD incidence (n=31768; events=4845) excluding participants that died within the first 2 years of follow-up (317; note, for CVD incidence we also excluded 7209 with previous CVD disease).
*Adjusted for age, sex, education, sedentary behaviour (only models for moderate-to-vigorous physical activity), sleep pattern, obesity, smoking, and alcohol use. CVD, cardiovascular disease. Dose-response associations were assessed with restricted cubic splines with knots at 10th, 50th, and 90th centiles of the distribution of the exposure of interest (reference category = 675.36 and 695.52 minutes/week of moderate-to-vigorous physical activity for mortality outcomes and CVD incidence respectively; and 39.10 and 39.70 milligravities (mg) for total volume of physical activity for mortality outcomes and CVD incidence respectively). Hazard ratios are in logarithmic scale.
Figure S6. Dose–response association (Adjusted* hazard ratios and associated 95% confidence interval band) between accelerometer-measured moderate-to-vigorous physical activity and total volume of physical activity with all-cause and CVD mortality with additional adjustment for diet.

*Adjusted for age, sex, education, sedentary behaviour (only models for moderate-to-vigorous physical activity), sleep pattern, obesity, smoking, alcohol use, and diet. CVD, cardiovascular disease. Dose-response associations were assessed with restricted cubic splines with knots at 10th, 50th, and 90th centiles of the distribution of the exposure of interest. Hazard ratios are in logarithmic scale.
Figure S7. Dose–response association (Adjusted* hazard ratios and associated 95% confidence interval band) between accelerometer-measured moderate-to-vigorous physical activity and total volume of physical activity with all-cause and CVD mortality with additional adjustment for blood pressure.

*Adjusted for age, sex, education, sedentary behaviour (only models for moderate-to-vigorous physical activity), sleep pattern, obesity, smoking, alcohol use, and mean arterial pressure. CVD, cardiovascular disease. Dose-response associations were assessed with restricted cubic splines with knots at 10th, 50th, and 90th centiles of the distribution of the exposure of interest. Hazard ratios are in logarithmic scale.
Figure S8. Dose–response association (Adjusted* hazard ratios and associated 95% confidence interval band) between accelerometer-measured moderate-to-vigorous physical activity and total volume of physical activity with all-cause and CVD mortality with additional adjustment for pre-existing CVD and Hb1Ac.

*Adjusted for age, sex, education, sedentary behaviour (only models for moderate-to-vigorous physical activity), sleep pattern, obesity, smoking, alcohol use, and pre-existing CVD and Hb1Ac. CVD, cardiovascular disease. Dose-response associations were assessed with restricted cubic splines with knots at 10th, 50th, and 90th centiles of the distribution of the exposure of interest. Hazard ratios are in logarithmic scale.
Figure S9. Dose–response association (Adjusted* hazard ratios and associated 95% confidence interval band) between total volume of physical activity while awake (7am to pm and 6am to 10pm) with all-cause mortality.

*Adjusted for age, sex, education, sedentary behaviour (only models for moderate-to-vigorous physical activity), sleep pattern, obesity, smoking, and alcohol use. Dose-response associations were assessed with restricted cubic splines with knots at 10th, 50th, and 90th centiles of the distribution of the exposure of interest. Hazard ratios are in logarithmic scale.