Institute of Education

UCL

1970 British Cohort Study: Age 46 Survey

Accelerometry User Guide

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CENTRE FOR LONGITUDINAL STUDIES

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Contents

Background and introduction

Free-living physical activity and sedentary behaviour can be measured objectively using a combination of thigh inclination and acceleration. Accelerometers are electro-mechanical devices that measure acceleration force. Cohort members were asked to wear thigh-worn accelerometers for one week as part of the Age 46 Survey. This is the first time accelerometry has been included on BCS70. Further information about the implementation of accelerometry on the Age 46 Survey can be found in the Technical Report.

Device

The study used the thigh-mounted activPAL3 micro triaxial accelerometer (PAL Technologies Ltd., Glasgow, UK). The device uses derived information about thigh position and acceleration to estimate body posture (i.e., sitting/lying and upright) and transition between these postures, stepping, and stepping speed (cadence). It is designed specifically to produce accurate measures of sedentary behaviour, which was of particular interest for the BCS70 cohort.

Devices were programmed to sample at the default frequency of 20 Hz. The device was waterproofed and fitted by a trained nurse on the midline anterior aspect of the upper thigh as recommended by the manufacturer.

Protocols

We utilised a wear protocol previously developed (Dall et al. 2018). Participants were requested to wear the device continuously for seven days, including when sleeping, bathing, swimming, and for all physical activities. Participants were instructed not to re-attach the device if it fell off or was removed before the stated end date. Participants were provided with instructions at the time of the visit (see Appendix 1).

Participants were also provided with a self-completion diary (see Appendix 2), where they were asked to provide information about their sleep (the time they went to bed, the time they woke up, and how many times they got up in the night), as well as details around early removal of the monitor if applicable. The diary questions can be used for accelerometer data quality monitoring.

After the week of data collection was over, cohort members were asked to post the device back using a pre-paid envelope.

Exclusion criteria

Respondents are excluded from the activity monitoring task if they:

- Were allergic to plasters or adhesives;

- Were allergic to low-density polyethylene (LDPE) (the plastic packaging the activity monitors were sealed in);
- Had a skin condition that would prevent them from wearing the monitor (e.g. broken skin / eczema on their legs), or;
- Were going through a metal detector/security checkpoint (e.g. at an airport) in the next week.

Data processing

Data were downloaded as DATX files, processed through activPAL3 software to create "eventsXYZ" files. A freely available program, called Processing PAL, was used to process the data (https://github.com/UOL-COLS/ProcessingPAL/releases/tag/V1.0), which has been previously validated (Winkler et al. 2016). The software uses an algorithm to isolate valid waking wear data from sleep or prolonged non-wear. The algorithm rules have been summarized elsewhere (Winkler et al. 2016). The first partial day was removed and subsequent days were defined from midnight to midnight. A wide range of outputs were derived for each individual wear day and mean daily averages were generated. Participants were included if they recorded at least 10 hours of valid wear time over a day during the monitoring period. The decision rules for processing the data are described in Appendix 3.

Dataset structure

The accelerometry deposit consists of two datasets. 'bcs10_activpal_days' contains summary data for each day of wear (one row per day) for up to eight consecutive days. For each day there are variables for the day of the week of wear (B10AWKDY), and the month (B10AMNTH) and year (B10AYEAR) the monitor was attached.

Though cohort members were instructed not to remove the monitor in this time, recorded days in the dataset are not necessarily consecutive if certain days of data were insufficient for summary variables to be produced. Non-consecutive days can be identified using B10AWKDY.

The second dataset, 'bcs_activpal_avg', contains computed daily average summary variables across all valid days of wear in 'bcs_activpal_days'.

Metrics

From the 8,581 participants in the Age 46 Survey, 6,492 consented to wearing the activity monitor, and of those 5,569 returned their monitors with useable data for at least one day of wear. 3,646 cohort members wore the monitor for the full week.

Defining moderate-vigorous physical activity

We used a step cadence threshold ≥ 100 in order to derive moderate – vigorous intensity physical activity (MVPA), as validated by Tudor-Locke et al. (2019).

Derived variables

The summary variables in both datasets (derived from the raw data) are described in the table below.

Daily variable	Avg variable	Description
B10ASITN1	-	Number of sitting bouts over the day lasting between 0-30 min
B10ASITN2	-	Number of sitting bouts over the day lasting between 30-60 min
B10ASITN3	-	Number of sitting bouts over the day lasting more than 60 min
B10ASTDN1	-	Number of standing bouts over the day lasting between 0-30 min
B10ASTDN2	-	Number of standing bouts over the day lasting more than 30 min
B10ASTEPN	-	Number of activity bouts over the day lasting between 0-30 min
B10AMVPAN1	-	No. of activity bouts (moderate to vigorous intensity) lasting between 0-10 min
B10AMVPAN2	-	No. of activity bouts (moderate to vigorous intensity) lasting more than 10 min
B10AWWT	B10AAWWT	(Mean) Wear time during waking hours (hr/d)
B10ASITH	B10AASITH	Total/Mean sitting time over the day (hr/d)
B10ASTDH	B10AASTDH	Total/Mean standing time over the day (hr/d)
B10ATSTEPH	B10AATSTEPH	Total/Mean activity time over the day (hr/d)
B10AMVPAH	B10AAMVPAH	Total/Mean activity time of moderate to vigorous intensity over the day (hr/d)
B10ASITN	B10AASITN	Total/Mean number of sitting bouts
B10ASTDN	B10AASTDN	Total/Mean number of standing bouts
B10ATSTEPT	B10AATSTEPT	(Mean) Daily step count
B10ASTUPN	B10AASTUPN	(Mean) Number of transitions from sitting to standing
B10ASITH1	B10AASITH1	Total/Mean sitting time for bouts lasting 0-30 min (hr/d)
B10ASITH2	B10AASITH2	Total/Mean sitting time for bouts lasting 30-60 min (hr/d)
B10ASITH3	B10AASITH3	Total/Mean sitting time for bouts lasting more than 60 min (hr/d)
B10ASTDH1	B10AASTDH1	Total/Mean standing time for bouts lasting 0-30 min (hr/d)
B10ASTDH2	B10AASTDH2	Total/Mean standing time for bouts lasting more than 30 min (hr/d)
B10ASTDH3	B10AASTDH3	Total/Mean activity time for bouts lasting 0-30 min (hr/d)

Raw data availability

Raw accelerometer data files are available on request by contacting the Centre for Longitudinal Studies. The accompanying uncleaned self-completion sleep diary dataset is also only available by request.

References

Dall, P.M., Skelton, D.A., Dontje, M.L., Coulter, E.H., Stewart, S., Cox, S.R., Shaw, R.J., Čukić, I., Fitzsimons, C.F., Greig, C.A., Granat, M.H., Der, G., Deary, I.J., Chastin, S. (2018) Characteristics of a protocol to collect objective physical activity/sedentary behaviour data in a large study: Seniors USP (understanding sedentary patterns). *Journal for the Measurement of Physical Behaviour*, 1(1): 26-31.

Tudor-Locke, C., Aguiar, E.J., Han, H., Ducharme, S.W., Schuna, J.M. Jr, Barreira, T.V., Moore, C.C., Busa, M.A., Lim, J., Sirard, J.R., Chipkin, S.R., Staudenmayer, J. (2019) Walking cadence (steps/min) and intensity in 21-40 year olds: CADENCE-adults. *International Journal of Behavioral Nutrition and Physical Activity*, 16(1): 8.

Winkler, E.A., Bodicoat, D.H., Healy, G.N., Bakrania, K., Yates, T., Owen, N., Dunstan, D.W. and Edwardson, C.L. (2016) Identifying adults' valid waking wear time by automated estimation in activPAL data collected with a 24 h wear protocol. *Physiological Measurement*, 37(10):1653-1668.

Appendix 1. Participant instructions

ACTIVITY MONITORING

MORE INFORMATION

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1970 British Cohort Study

WHAT IS ACTIVITY MONITORING?

We would like you to wear an activity monitor, a small device that records body movements during normal daily activities such as standing up, walking or running. It also captures inactive periods such as time spent sitting or sleeping.

Studies have shown that the time people spend doing physical activity, versus being inactive, can affect their physical and mental health. However, these studies usually rely on asking people to remember the amount of time they have spent doing different activities, which can give inaccurate results.

The information recorded by the activity monitors will let researchers look at the link between physical activity and health in much more detail.

HOW SHOULD I WEAR THE ACTIVITY MONITOR?

During the interview, your nurse interviewer will instruct you on how to wear the monitor and will attach it to the front of your thigh (or you can do this yourself) using a special dressing. Please do not change the positioning of the monitor once it is fixed in place as this will affect the quality of the data.

HOW LONG DO I NEED TO WEAR IT FOR?

You should leave it on for 7 full days starting from the day after your interview. Please do not take the monitor off at any time during this period. If the monitor is removed, the data collected during that time will not reflect your true activity levels. The monitor can be worn comfortably at night.

Your nurse interviewer will let you know when the monitor should be taken off.

SHOULD I TAKE IT OFF WHEN I'M IN THE SHOWER?

No. It is waterproof. You can even wear it in the bath or while swimming. We would like you to wear it when you are doing all activities, including water sports, and it is safe for you to do this.

CAN THE MONITOR TRACK MY WHEREABOUTS?

No, the monitor has no GPS technology or camera, and cannot track your whereabouts.

ACTIVE OR INACTIVE: WE'RE INTERESTED IN YOUR ACTIVITY PATTERNS

IS THERE ANYTHING ELSE I NEED TO DO?

We would also like you to complete a sleep diary for the period that you are wearing the activity monitor. This will help us interpret the information collected by the activity monitor. It will also act as a reminder of when you can remove the monitor.

WHAT IF I AM GOING THROUGH A METAL DETECTOR OR SCANNER?

The monitor should not set off a metal detector or scanner. However, if you will be passing through an airport security checkpoint in the next 7 days, we suggest that you remove the monitor beforehand. If you will be passing through a metal detector or scanner somewhere else, for example, at your place of work there should be no need to remove the device, unless you feel that it could be a problem if the device was identified.

WHAT IF I AM SICK OR CANNOT DO MUCH PHYSICAL ACTIVITY FOR ANY REASON DURING THE DAYS I AM WEARING THE DEVICE?

Please wear the monitor as normal. We are interested in your physical activity patterns no matter how inactive or active you are.

WHAT IF I DON'T WEAR THE MONITOR FOR THE FULL 7 DAYS?

If you have to take the monitor off before the end of your 7 days, please use the sleep diary to record the date and time you did so, and why you took it off. The dressing used to attach the monitor is regularly used in hospitals and is very unlikely to cause any skin irritation. In the unlikely event that the dressing does cause any skin irritation please remove it. Please do **not** reattach the monitor to your thigh.

WHAT DO I DO AFTER I HAVE WORN THE MONITOR FOR 7 DAYS?

Once your 7 days are over, you will receive a text message and email to remind you that the monitor can be taken off and returned. Please post back the activity monitor, along with the sleep diary and feedback form, in the pre-paid envelope provided by the nurse interviewer as soon as you can.

If you lose the return envelope and need another one please contact NatCen on 0800 526 397.

WILL I GET ANY FEEDBACK ABOUT MY ACTIVITY LEVELS?

Yes, we can send you a summary report of your physical activity during the week you have worn the activity monitor.

IF I HAVE ANY OTHER QUESTIONS?

If you have any further questions about the activity monitor, you can:

- contact the NatCen research team at bcs70@natcen.ac.uk,
- or call NatCen Freephone on 0800 526 397.

If you would like to find out more about the 1970 British Cohort Study you can,

- visit www.BCS70.info
- email CLS at bcs70@ioe.ac.uk
- or call CLS Freephone on 0500 600 616

THANK YOU FOR YOUR HELP

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Social Research that works for society

Appendix 2. Self-completion sleep diary

ATTACH SLEEP DIARY BARCODE FROM CONSENT BOOKLET HERE.

SLEEP DIARY

ACTIVITY MONITOR LOG

It is important that you wear the activity monitor for 7 full, consecutive days.

For each day you are wearing the monitor, please use this sheet to write down the times you went to bed and went to sleep, when you woke up and got out of bed and how well you slept. Please remember to fill in the diary on the day after you take the monitor off (day 8) too.

Please use the 12 hour clock and tick AM or PM.

If you have to remove the monitor, or it falls off, before the end of the seven day period, please record this on the reverse page. We would like to know when you took it off/ it fell off, and the reason why (if applicable).

1970 BRITISH COHORT STUDY: 2016-17 SURVEY

NURSE TO ENTER:

Nurse ID Number

Participant First Name

Participant Gender M F

Participant Date of Birth 0 4 1 9 7 0

	DAY 1	DAY 2	DAY 3	DAY 4
Enter day of the week				
Enter date				
What time did you go to bed last night?	H H : M M A M / P M	H H : M M A M / P M	H H : M M A M / P M	H H : M M A M / P M
What time do you think you fell asleep?	H H : M M A M / P M	H H : M M A M / P M	H H : M M A M / P M	H H : M M A M / P M
How many times did you get out of bed during the night?				
How did you sleep last night? (Please tick one box)	Very badly 1 2 3 4 5 6 7 8 9 Very well 10	Very badly 1 2 3 4 5 6 7 8 9 Very well 10	Very badly 1 2 3 4 5 6 7 8 9 Very well 10	Very badly 1 2 3 4 5 6 7 8 9 Very well 10
What time did you wake up this morning?	H H : M M A M / P M	H H : M M A M / P M	H H : M M A M / P M	H H : M M A M / P M
What time did you get out of bed this morning?	H H : M M A M / P M	H H : M M A M / P M	H H : M M A M / P M	H H : M M A M / P M

	DAY 5	DAY 6	DAY 7*	DAY 8**
Enter day of the week				
Enter date				
What time did you go to bed last night?	H H : M M A M / P M	H H : M M A M / P M	H H : M M A M / P M	H H : M M A M / P M
What time do you think you fell asleep?	H H : M M A M / P M	H H : M M A M / P M	H H : M M A M / P M	H H : M M A M / P M
How many times did you get out of bed during the night?				
How did you sleep last night? (Please tick one box)	Very badly 1 2 3 4 5 6 7 8 9 Very well 10	Very badly 1 2 3 4 5 6 7 8 9 Very well 10	Very badly 1 2 3 4 5 6 7 8 9 Very well 10	Very badly 1 2 3 4 5 6 7 8 9 Very well 10
What time did you wake up this morning?	H H : M M A M / P M	H H : M M A M / P M	H H : M M A M / P M	Thank you! You have provided all the information we need. Please return your diary and monitor in the envelope provided
What time did you get out of bed this morning?	H H : M M A M / P M	H H : M M A M / P M	H H : M M A M / P M	

Did you remove the monitor, or did it fall off, at any time before the end of the 7 day period? *(Please circle your answer)*

No – end
Yes – please go to the next question

When did the monitor fall off, or was removed?

D D : M M : Y Y
H H : M M
A M / P M

Why did you remove the monitor (if applicable)? *(Please write in your answer below)*

*Last day wearing the monitor. Take it off before going to bed

**Last day of completing the diary

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Appendix 3. The decision rules applied to process data files.

Sleep and non-wear settings:

Longest bout – 300 minutes

Long bout – 120 minutes

Shortest bout – 30 minutes

Check window length – 15 minutes

Maximum number of steps – 20

Sleep/non-wear bouts were identified as (1) the longest lying/sitting bout per 24 h period (from noon-to-noon each day) that lasted **≥120 minutes**, or (2) any very long bouts lasting **≥300 minutes**. This permits sleep/non-wear to occur at any time, any number of times (including never) within a 24 hour window. Since sleep can register as multiple periods of sitting/lying interspersed with real or erroneously detected posture changes and stepping, the next step iteratively examined surrounding bouts and determined whether they were more likely additional sleep/non-wear (limited movement) or waking wear (more movement). Bouts were deemed 'surrounding' if any portion was within a **15 minute window** before or after a sleep/non-wear bout. All bouts in the sleep window were classed as sleep/non-wear when the window contained any of the following: **a long (>120 minutes) sitting/lying or standing bout, or moderately long (≥30 minutes) with very few (≤20) steps in between**; a sleeping/non-wear bout; or, posture changes without intervening steps. This step was repeated until no further sleep/non-wear was found.

Analysis settings:

Ignore first day in processing

Validation settings:

Maximum % of an activity in a day – 95

Minimum number of steps in a day – 500

Minimum duration of data in hours per day - 10

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