NATIONAL HEALTH AND AGING TRENDS STUDY (NHATS)

ACCELEROMETRY USER GUIDE

Rounds 11-12 Final Release

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Overview

This document describes the collection of physical activity data using wrist accelerometry in the National Health and Aging Trends Study (NHATS). Data were collected using the Actigraph CentrePoint Insight Watch ("Activity Watch"), a research grade accelerometer that is triaxial and water-resistant. The Activity Watch continuously measures acceleration to estimate intensity, duration, and frequency of physical activity. Sample persons were fitted with the Activity Watch during their in-home interview and asked to continue wearing the device at all times for the 7 days following their interview. This raw accelerometry data was processed to obtain estimates of active and non-active time in NHATS participants. This user guide provides details on the methodology, collection, data files, variables, and documentation to facilitate analysis of the data.

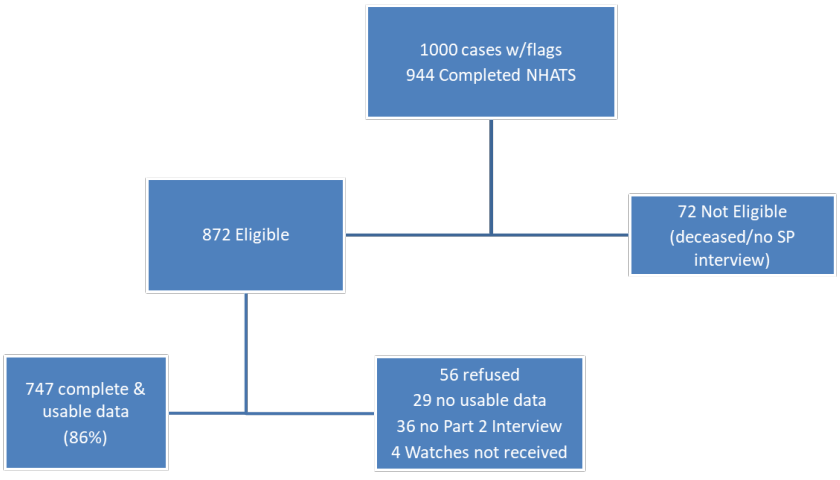
Accelerometry Pilot Study

To identify operational issues and evaluate data quality for the proposed accelerometry protocol, NHATS incorporated a pilot study into Round 9 (N=45 sample persons). The pilot study found that respondents were highly likely to participate, with compliance rates exceeding 90%. Data were high-quality, with low rates of non-wear, demonstrating that objective physical activity monitoring could be successfully incorporated into NHATS. Based on the pilot study results, the sample was expanded to 1,000 sample persons in 2021. These participants will be followed longitudinally in 2022 and 2023 (Rounds 12 and 13).

Eligibility & Response Rates

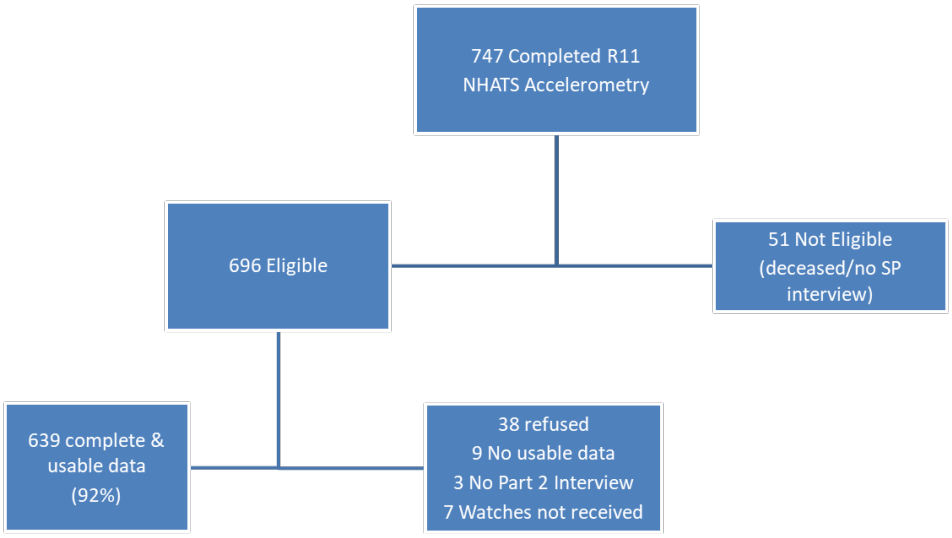
Round 11

1,000 NHATS participants who were eligible for a sample person (SP) interview in Round 11 were flagged to wear the accelerometer. The accelerometry sample was selected proportional to the Round 9 analytic weight. Of the 1000 sample persons selected, 944 completed NHATS in Round 11 and 872 were eligible to wear the Watch. Of those eligible 747 (86%) returned an Activity Watch with usable data.



Round 12

The 747 NHATS participants who wore the accelerometer in Round 11 and were eligible for a sample person (SP) interview in Round 12 were flagged to wear the accelerometer. Of the 747 sample persons, 696 were eligible to wear the Watch in Round 12, 24 were deceased, and 27 did not have an SP interview. Of those eligible 639 (92%) returned an Activity Watch with usable data.



Wear Methodology

Sample persons were asked to wear the Activity Watch 24 hours/day on their non-dominant wrist for the seven days following the interview day (8 days total). Participants were instructed to wear the Activity Watch at all times, removing only for swimming or bathing lasting longer than 30 minutes. The Activity Watch records movement using an accelerometer sensor in units of gravity (g) at a sampling rate of 64 Hz. After the collection period, sample persons returned the Activity Watch to Westat offices using postage-paid padded mailers.

Interviewer Training & Evaluation

A standardized interviewer training was developed consisting of: (1) a home-study component and (2) hands-on training component.

The home study component was completed prior to the hands-on training. The home study consisted of multiple exercises including a review of the procedure manual describing the protocol in detail and a series of videos and exercises to aid in understanding how to initialize the Activity Watch.

Interviewers then completed an additional hands-on training that focused on setting up the activity in CAPI, initializing the Activity Watch, and describing the wear protocol to sample persons. Interviewers practiced assigning, un-assigning, and reassigning the Activity Watch.

Follow-up during the field period included data monitoring and data quality checks and targeted re-training as needed.

Data Collection Protocol

Equipment. Each interviewer was provided with a laptop with computer-assisted personal interview (CAPI) instrument software and a login ID for the Actigraph CentrePoint cloud-based software. Interviewers were instructed to fully charge the Activity Watch and assign it to the sample person using the CentrePoint software before the home visit to avoid difficulties with internet access in the sample person's home and to save time during the interview. Sample persons were asked to wear the Activity Watch for seven days after the interview day (8 days total), 24 hours per day. If the sample person agreed to wear the Activity Watch, they were fitted with the device and provided instructions on the date and time to remove the Activity Watch and place it in the mail for return.

The Westat home office tracked the return and receipt of the Activity Watches using USPS tracking numbers. All sample persons were mailed a postcard reminding them to return the Activity Watch, which was timed to arrive at the sample person's home within a day or so of when the Activity Watch was due to be mailed. If the Westat office did not receive the Activity Watch within 10 days of when it was expected, the data collectors were asked to follow-up with the sample person, reminding them to mail back the Activity Watch.

Data Processing

Upon receipt of the Activity Watch by the Westat office, data were uploaded to the CentrePoint cloud. The data were downloaded and processed using minute level epochs by the Johns Hopkins Accelerometry Core to generate summary and detailed files. Data were processed using the R ARCTOOLS package. Manuals and examples for using ARCTOOLS are publicly available: https://www.rdocumentation.org/packages/arctools/versions/1.1.4. Data were processed for wear time compliance. Nonwear time was estimated using a 90 consecutive minutes threshold.[1] A valid day was defined as >90% wear, or 1296 minutes per day.[2,3] For periods of missing data on valid days (<10% of the day missing), activity counts were imputed using the average activity counts observed for that participant for the same time period/minutes from other valid days (< 8 minutes on average).[2]

Variable Names and Missing Data Conventions

Variable names. Variable names for accelerometry follow a standard convention. Variables start with "ag" (for Actigraph), followed by NHATS round number (e.g. 11). This "stem" is followed by a name that reflects the specific activity variable.

Derived variable names. Variables that are created for users ("derived" variables) use the same naming convention as other variable names, but a "d" is included after the round number.

Missing Data. Accelerometry files use the NHATS conventions of assigning -9 to missing.

Weights and Using NHATS Weights and Design Variables in Analyses

Round 11 accelerometry data are designed to be nationally representative of living Medicare beneficiaries (in 2021, ages 71 and older). Round 12 accelerometry data are based on a longitudinal design and represents outcomes in 2022 for living Medicare beneficiaries ages 71 and older in 2021. To make statements that are generalizable to this population, the data must be weighted and design variables must be used to account for NHATS' complex survey design. Details about accounting for NHATS' complex survey design features can be found in Freedman et al. (2022) available at www.nhats.org. The weights and design variables for the accelerometry data are found on the Accelerometry Summary File from the same year. An overview of weights and design variables can be found in Table 1 below.

Table 1. Overview of Weight Variables for NHATS accelerometry data analyses.

	Sample	Full sample weight	Replicate weights	Stratum	Cluster
Round 11	Cross-sectional	w11agfinwgt0	w11agfinwgt1-56	w11agvarstrat	w11agvarunit
Round 12	Longitudinal	w12agfinwgt0	w12agfinwgt1-56	w12agvarstrat	w12agvarunit

As an example, Stata, SAS and R code for merging and running weighted analyses with accelerometry data are shown below.

Stata Commands. In Stata, users should specify the following svyset command .

```
*specify survey design for weighted analysis
svyset w#agvarunit [pweight= w#agfinwgt0], strata(w#agvarstrat)
svy: [stata procedures]
```

SAS Commands.

```
[sas survey procedure];
weight w#agfinwgt0;
cluster w#agvarunit;
strata w#agvarstrat;
[model or other statement];
run;
```

R Commands.

```
library(survey) #need this line only once per session
nhats.dsgn <- svydesign(id=~ w#agvarunit, strata=~ w#agvarstrat, weights=~
w#agfinwgt0, data = newname, nest=TRUE)
[model or other statement]
```

Obtaining Accelerometry Data

The summary and detailed accelerometry files are designated as public for purposes of data release. The Instruments and Crosswalk are available at www.nhats.org. To obtain the data files and codebook, go to: https://nhats.org/researcher/nhats. Raw individual data files are available upon request. Please contact: nhatsdata@westat.com. For details on the development of Round 11 accelerometry weights, please see Jiao et al. (2022)[4]. Development of the Round 12 accelerometry weights are described in Jiao et al. (2023)[5].

Appendix A. Accelerometry Summary Variables

Variable Name	VARIABLE LABEL	R11 Values	R12 Values	Interpretation
ag#dnumdays	R# D NUMBER OF DAYS DEVICE WORN	6-8 days	4-8 days	Number of days the participant wore the device
ag#dnumdaysval	R# D NUM DAYS DEVICE WORN MORE THAN 21.6 HRS	1-8 days	1-8 days	Number of valid days the participant wore the device (wear time >90% of the day)
ag#dnummin	R# D NUM MINUTES DEV WORN ON VALID DAYS	1308-1440 min	1316-1440 min	Number of minutes the device was worn on valid days
ag#dtac	R# D TOTAL ACTIVITY COUNTS	20,183-4,300,000 counts	175,989-4,300,265 counts	Vector magnitude of total activity counts across the three axes
ag#dltac	R# D LOG OF TOTAL ACTIVITY COUNTS	9.5-16.0 log counts	12.1-15.3 log counts	Logarithmic value of vector magnitude of total activity counts across the three axes
ag#dastp	R# D ACTIVE TO SEDENTARY TRANSITION PROB	9.0-79.5%	10.2-91.2%	Probability of transitioning from an active state to a sedentary state. A measure of activity fragmentation.[6]
ag#dsatp	R# D SEDENTARY TO ACTIVE TRANSITION PROB	0.05-18.5%	0.1-17.7%	Probability of transitioning from a sedentary state to an active state. A measure of sedentary behavior fragmentation.[7]
ag#dminact	R# D SUM MINUTES ACTIVE PER DAY	0-745 min	1.5-716 min	Number of minutes per day spent above a threshold of 1853 counts per minute.[8]
ag#dminnon	R# D NUM MINUTES NONACTIVE PER DAY	695-1440 min	724.1-1439 min	Number of minutes per day spent below a threshold of 1853 counts per minute.[8]
ag#dactnum	R# D NUM ACTIVE BOUTS PER DAY	0-145 bouts	1.5-146 bouts	Number of active bouts, where a bout is defined as an uninterrupted sequence of $\geq$1 active minutes (minutes with >1853 activity counts)
ag#dnonnum	R# D NUM NONACTIVE BOUTS PER DAY	1-145 bouts	1.6-146 bouts	Number of nonactive bouts per day, where a bout is defined as an uninterrupted sequence of $\geq$1 nonactive minutes (minutes with $\leq$1853 activity counts)
ag#dactlen	R# D MEAN LENGTH ACTIVE BOUTS	0-10.5 min	1-9.8 min	Average length of each active bout

ag#dnonlen	R# D MEAN LENGTH NONACTIVE BOUTS	5.0-1440 min	5.7-886 min	Average length of each nonactive bout
ag#dmax10	R# D MAX ACTIVITY COUNTS IN 10 CONSEC MIN	357-20,131	730-17,773	Maximum activity counts per minute accumulated in 10 consecutive minutes
ag#dmax30	R# D MAX ACTIVITY COUNTS IN 30 CONSEC MIN	145-16,085	528-14,282	Maximum activity counts per minute accumulated in 30 consecutive minutes
ag#dmax60	R# D MAX ACTIVITY COUNTS IN 60 CONSEC MIN	84-12,270	430-11,206	Maximum activity counts per minute accumulated in 60 consecutive minutes

All summary metrics are reported as the average across all valid days.
Note that this is a 24-hour wear protocol that does not differentiate sleep from wake.

Appendix B. Accelerometry Detailed Variables

Variable Name	**VARIABLE LABEL**	**R11 Values**	**R12 Values**	**Interpretation**
ag#dday	R# D DAY DEVICE WORN	1-8	1-8	Day number the participant wore the device
ag#dwday	R# D WEEK DAY DEVICE WORN	1 (Sunday)-7 (Saturday)	1 (Sunday)-7 (Saturday)	Day of the week the participant wore the device
ag#dvalid	R# D DEV WORN MORE THAN 21.6 HOURS	1-2	1-2	Denotes whether the device was worn >21.6 hours: 1 “YES” and 2 “NO”
ag#dmeanmin1	R# D MEAN ACTIVITY COUNT MIN 1	0-9640	0-10,963	Mean activity counts at 12:00AM
ag#dmeanmin2	R# D MEAN ACTIVITY COUNT MIN 2	0-16,230	0-13,231	Mean activity counts at 12:01AM
…				
ag#dmeanmin1440	R# D MEAN ACTIVITY COUNT MIN 1440	0-9,395	0-9,776	Mean activity counts at 11:59PM

References

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