MULTICENTER OSTEOARTHRITIS STUDY

144-MONTH ACCELEROMETRY (AX3)

DATASET DESCRIPTION AND ANALYST NOTES

MARCH 2023

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1. INTRODUCTION

The Multicenter Osteoarthritis Study (MOST) is a longitudinal, prospective, observational study of knee osteoarthritis (OA) in older Americans with knee OA disease or at increased risk of developing it.

Accurate and reliable assessment of gait and physical activity remains an important measurement for epidemiologists, exercise scientists, clinicians, and behavioral researchers. Recent advances in accelerometers, which quantify body movements by measuring acceleration in multiple planes, offer a cost-effective way to objectively record gait and physical activity. Accelerometry is considered to be the "gold standard" for measuring gait and habitual physical activity.

MOST used a small (2.3cm x 3.2cm x 0.7cm), lightweight (11gm) activity monitor (AX3 Logging Accelerometer, Axivity Ltd, York, UK) that was worn on a belt on the lower back. All participants started wearing the device at the end of their 144-month clinic visit and were given a self-addressed postage-paid envelope to mail the device back to the clinic at the end of the seven days.

Examiners responsible for conducting assessments using the AX3 monitor have undergone on-site training by an experienced investigator. Certification required that examiners complete all training requirements including demonstrating that they understood the correct set up and return procedures. Examiners also conducted the exam on two volunteers. Examiners were also recertified midway through the examination cycle. Processing of the accelerometer data in order to extract the parameters of interest was performed by the Accelerometry Reading Center (ARC), supervised by Dr. Jeff Hausdorff, in his laboratory at Tel Aviv University.

See additional documentation "MOST_GaitBalanceActivityOutcomeVariables.pdf" for more information.

2. DATA MANAGEMENT

Transfer of digital exam data to the UCSF Coordinating Center (CC). Digital examination data were transferred regularly from the clinics to the UCSF CC over the internet using a secure data transfer method and following data transfer SOPs detailing responsibilities of the sender and recipient.

Receipt of data at UCSF CC.
Basic quality control checks done by UCSF CC before transfer to reading center

- Study identifiers on form match electronic file identifiers
- Study ID and Acrostic (second identifier) and date of exam (date of recording) must always match gold standard in master data system
- Confirm length of data is sufficient (determine using the file size)
- UCSF will provide reading centers the AX3 data files with this naming convention: DeviceID + MOSTID

Transfer of data to the reading center. At the CC, receipt and completeness of data collection was evaluated against measurement acquisition tracking data recorded by the clinics in the study database (see above). The CC notified reading centers when data passed quality assurance checks and was ready for the reading center to download from the secure FTP site or other prearranged method.

Transfer of data from the reading center to the CC. Reading center uploaded results of their analyses to the secure FTP server for integration into the study database.

3. OVERVIEW OF DATASET AND ANALYST NOTES

All participants were eligible for the AX3 protocol during the 144m clinic visit (see "Accelerometry (AX3)" Operations Manual for the 144-month clinic visit protocol available at https://agingresearchbiobank.nia.nih.gov/studies/most/documents/?f=Manual_of_Procedures). Note: there are cohort and clinic differences in who wore the AX3 device, whether device was returned with or without data, and whether the AX3 questionnaire was distributed/returned with the AX3 device. Data on these parameters are in the dataset V7ENROLL. The CC recommends controlling for cohort and clinic in all analyses.

Variables were derived from raw AX3 data files obtained as a part of the MOST 144m clinic visit at the Accelerometry Reading Center (ARC; reader I. Hillel, supervisor J. Hausdorff). For this study the reader was blinded to clinical data and demographic characteristics of the participants.

A report on completeness of 144m AX3 data collection and reading center processing is provided in Appendix 3.

See the documentation titled "MOST_GaitBalanceActivityOutcomeVariables.pdf" for detailed descriptions of variables and calculation methods.

144-month AX3 Days Dataset (V7AX3_DAYS.sas7bdat)

Records: 16,641 records (2393 participants; 1 to 7 days of data per participant)
Variable Guide: VariableGuide_V7AX3_DAYS.pdf
Distributions: Distributions_ V7AX3_DAYS.pdf
Cohort: Existing and New Cohort

*The **V7AX3_DAYS*** dataset contains 16,641 records, one record for each day for up to 7 days of data for each participant.

Daily **Activity** variables for each day are calculated using data from AX3 wear time occurring over 24 hours. Activity variables are calculated for each day in which the participant wore the AX3 device (i.e. any wear time detected). This will include some days in which very little wear time was recorded. Meta-data variables for daily minutes of wear time (see below) can be used to filter records for a minimum duration of wear time.

Daily **Gait Quality** variables are calculated using all detected walking (gait) bouts of 60 seconds duration that occurred during each 24 hour day that the participant wore the device and for which at least one walking bout of the required duration was detected. Gait measures are calculated separately for each 60s bout and the daily variables were calculated to summarize the distribution of the measures over all the bouts of the respective duration on a given day (n, median, mean, SD, min, max for each variable).

Daily **Meta-data** variables describe the data collection process for each participant on a daily basis. These include the day number, minutes of wear time for the day, and whether the amount of wear time for that day reaches thresholds of at least 6 hours and 10 hours.

144-month AX3 Summary Dataset (V7AX3_SUMMARY.SAS7BDAT)

Records: 2393 records (2393 participants)
Variable Guide: VariableGuide_V7AX3_SUMMARY.pdf
Distributions: Distributions_ V7AX3_SUMMARY.pdf
Cohort: Existing and New Cohorts

*The **V7AX3_SUMMARY*** dataset contains one records per participant: 1) a record for the Activity variables and Meta-data collected during wear time over the 24 hour time frame and for one gait variable with data from 60 sec walking bouts.

The Summary variables in each record summarize the Activity variables and the Meta-data variables over all the days with any wear time. There are Summary variables calculated by ARC and Summary variables calculated by the CC. Those calculated by the CC only use data collected from days 1 to 7 (the MOST protocol), whereas those calculated by ARC may include data from days 0 and 8. Some of these Summary variables only use data from days that meet requirements for the minimum number of hours of wear time.

Details on calculation of the ARC and CC Summary variables are in the Analyst Notes below and in Appendix 1.

IMPORTANT ANALYST NOTES:

Dataset V7AX3_DAYS

- Dataset V7AX3_DAYS contains daily output: 1 record per MOSTID+DayNumber; Activity characteristics from the 24 hours day 0:00-23:59 and Gait characteristics from 60 sec bouts.

- Variable #4 DayNumber. All days in the processed data were enumerated from 0 to 8. However, only days 1 to 7 are considered valid according to the protocol and therefore included in the dataset. At day number 0 (clinic visit and day device given to participant) the device was programmed to start recording at 4:00 pm and at day 8 (device return day) the participant was instructed to stop device. Occasionally some participants wore device longer but additional days were not processed by the Accelerometry Reading Center (ARC).

- If there were some discrepancies between filename listed on forms and what is programmed in the annotation field from AX3 device (approximately 4% across both clinics) data was not prepared for analysis (and therefore not included in this dataset).

- Variables #5 to #24 are the Activity variables calculated by ARC. Note: the original output for number of minutes of specific activity types (e.g. walking) used floating decimal points format. Variables #5-#8 were rounded to the nearest integer by the Coordinating Center. There are unexpected minor discrepancies. For example, the Meta-data variable arc_MinutesRecorded is not always equal to arc_MinutesWearTime plus arc_MinutesNonWear due to rounding. All specific activity time variables (walking time, lying time, sitting time, standing time, sedentary time and other time) are provided in the floating decimal point format.

- Variables #25 to #200 were provided by ARC and are the Gait Quality variables. Note: Gait Quality variable characteristics (median, mean, SD, min, max for each variable) were calculated for walking bouts if during 24 hours there are any 60 sec walking bouts. The bout level data was not provided so each parameter (total 35); instead parameters characteristics such as median, mean, SD, min and max are included in the dataset. The number of walking bouts used for the calculation of Gait Quality parameters is included in variable #25 NumberofWalkingBouts. This variable can be used as a filter to limit analyses of Gait Quality parameters to days with a sufficient number of walking bouts to be representative of a participants usual gait. The minutes of walking time variable, WalkingTime, can be used for the same purpose.

- Indicator variables #201 CC_valid6hr and #202 CC_valid10hr were calculated by the Coordinating Center to indicate if each day consisted of at least 6 hours of wear time or at least 10 hours wear time. These variables can be used as filters to limit analyses of Activity parameters to days with enough wear time to provide valid estimates of an individual's usual activity patterns.

Dataset V7AX3_SUMMARY

- Dataset V7AX3_SUMMARY contains summary of daily output: one record per MOSTID.

- Variables #4 to #6 were provided by ARC as a summary variables for Activity parameters. Note: valid days were not restricted to the day number 1 to 7 in these summary indicator variables. If day 0 (clinic visit day) or day 8 (programmed to stop day) recording was long enough it was used in the calculation for the summary variables.

- Variables #7 to #40 were calculated by the Coordinating Center to provide summary variables combining activity parameters calculated using data from days 1 to 7 only. See Appendix 1: N of 6 hour days, N of 10 hour days. The CC calculated daily and summary valid days variables are restricted to day number 1 to 7.

- Variables #41 to #46 were calculated by Coordinating Center using the daily dataset for days with 10 hours of valid data only. Analyst can re-calculate summary variables and check that calculation is matching to the variable values included in the summary dataset. In addition to the average of number of non-wear blocks, number of upside down blocks and step count, Coordinating Center choose to report the average of number of walking bouts and average of two gait parameters median values: ActivityLevel_med and StepTime_med.

- If there were some discrepancies between filename listed on the form and what is programmed in the annotation field from AX3 device (approximately 4% across both clinics), data was discarded as invalid and not included in the dataset.

4. REFERENCES

See “MOST_GaitBalanceActivityOutcomeVariables.pdf”.

APPENDIX 1: ADDITIONAL CALCULATED VARIABLES

In addition to the variables provided by the Accelerometry Reading Center, the MOST Coordinating Center created a number of calculated variables, prefixed with "CC". See variables #9 to #40 in the VariableGuide_V7AX3_SUMMARY.pdf.

Note: All of the CC calculated variables used data only from Days 1 – 7 inclusive. Any AX3 device recordings outside of this range fall outside of the exam protocol.

Note: the following measurements received from the Reading Center were rounded to the nearest minute: MinutesRecorded, MinutesWearTime, MinutesNoNWear, MinutesUpsideDownWear. The rounded values were used for all of the CC calculated variables.

CC_valid6hr = 1 on any day where MinutesWearTime >= 360
CC_valid10hr = 1 on any day where MinutesWearTime >= 600

CC_NumValidDays6hr = sum(CC_valid6hr) over Days 1 - 7
CC_NumValidDays10hr = sum(CC_valid10hr) over Days 1 - 7

These variables are summed over Days 1 - 7, regardless whether any given day met the threshold for valid 6 or 10 hours of wear time.

CC_PercentWalking = sum(WalkingTime)/sum(MinutesWearTime)*100
CC_PercentSitStand = sum(SittingStandingTime)/sum(MinutesWearTime)*100
CC_PercentLying = sum(LyingTime)/sum(MinutesWearTime)*100
CC_PercentOther = sum(OtherTime)/sum(MinutesWearTime)*100

These variables are similarly calculated as above, but only using days with CC_valid6hr = 1
CC_PercWalking6hr
CC_PercSitStand6hr
CC_PercLying6hr
CC_PercOther6hr

These variables are similarly calculated, but only using days with CC_valid10hr = 1
CC_PercWalking10hr
CC_PercSitStand10hr
CC_PercLying10hr
CC_PercOther10hr

The following variables take the mean of the respective variables only for days with at least 6 or 10 hours of valid wear time
CC_PercWalkingMean6hr = mean of the daily PercentWalking values on days with at least 6 valid hours of wear time
CC_PercSitStandMean6hr = mean of the daily PercentSittingStanding values on days with at least 6 valid hours of wear time
CC_PercLyingMean6hr = mean of the daily PercentLying values on days with at least 6 valid hours of wear time
CC_PercOtherMean6hr = mean of the daily PercentOther values on days with at least 6 valid hours of wear time

These variables are calculated similarly to the "6 hr" variables but only on CC_valid10hr = 1 days
CC_PercWalkingMean10hr
CC_PercSitStandMean10hr

CC_PercLyingMean10hr
CC_PercOtherMean10hr

The following variables sum the respective day-specific totals over all days (Days 1-7)

CC_MinWearTime_Summary = sum(MinutesWearTime)
CC_MinNonWear_Summary = sum(MinutesNoNWear)
CC_MinRecorded_Summary = sum(MinutesRecorded)
CC_MinUpDownWear_Summary = sum(MinutesUpsideDownWear)

The following variables sum the respective day-specific totals over all days (Days 1-7) where CC_valid6hr = 1

CC_MinWearTime6hr_Summary
CC_MinNonWear6hr_Summary
CC_MinRecorded6hr_Summary
CC_MinUpDown6hr_Summary
The following variables sum the respective day-specific totals over all days (Days 1-7) where CC_valid10hr = 1

CC_MinWearTime10hr_Summary
CC_MinNonWear10hr_Summary
CC_MinRecorded10hr_Summary
CC_MinUpDown10hr_Summary

APPENDIX 2: ACCELEROMETRY (AX3) OPERATIONS MANUAL (TABLE OF CONTENTS)

ACCELEROMETRY (AX3)

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Operations Manual for the 144-month clinic visit protocol available at https://agingresearchbiobank.nia.nih.gov/studies/most/documents/?f=Manual_of_Procedures

APPENDIX 3: AX3 DATA SUMMARY REPORT BY COHORT

MOST 144m AX3 summary; data received between March 2016 and September 2018

Table 1. AX3 device distribution status summary report - by cohort

	Original cohort		New cohort		Total	
	N	col%	N	col%	N	col%
Total CV	1309	100.0%	1525	100.0%	2,834	100.0%
Distribution status						
AX3 distributed	1173	89.6%	1446	94.8%	2,619	92.4%
1:Refused	84	6.4%	59	3.9%	143	5.0%
2:Cognitive impairment	9	0.7%	3	0.2%	12	0.4%
3:No device available	12	0.9%	9	0.6%	21	0.7%
4:Participant not reliable	3	0.2%	1	0.1%	4	0.1%
5:Physical/medical problem	0	0.0%	0	0.0%	0	0.0%
6:Other	11	0.8%	7	0.5%	18	0.6%
7:No belt available	2	0.2%	0	0.0%	2	0.0%
8:Equipment failure	0	0.0%	0	0.0%	0	0.0%
9:Waiting for IRB approval	6	0.5%	0	0.0%	6	0.2%
Reason unknown	9	0.7%	0	0.0%	9	0.3%

Table 2. AX3 data collection status summary report - by cohort

	Original cohort		New cohort		Total	
	N	col%	N	col%	N	col%
Total AX3 distributed	1173	100.0%	1446	100.0%	2,619	100.0%
Data collection status						
Device not returned/lost	16	1.4%	24	1.7%	40	1.5%
Device returned, data collected	1133	96.6%	1401	96.9%	2,534	96.7%
Device returned, data not collected	24	2.0%	21	1.5%	45	1.7%

Table 3. AX3 data processing status summary report - by cohort

	Original cohort		New cohort		Total	
	N	col%	N	col%	N	col%
Total AX3 data	1133	100.0%	1401	100.0%	2,534	100.0%
Processing status						
1:Data processed	1127	99.5%	1378	98.4%	2,505	98.8%
2:Unable to analyze	0	0.0%	0	0.0%	0	0.0%
9:Data collected-file lost or corrupted	6	0.5%	23	1.6%	29	1.1%

Table 4. AX3 data characteristics (includes only participants with data received and data processed by Reading Center (ARC).

	Original cohort		New cohort		Total	
	N	**col%**	**N**	**col%**	**N**	**col%**
Total AX3 processed by ARC	1127	100.0%	1378	100.0%	2,505	100.0%
Valid Days 10 hours (ARC)						
0 days	23	2.0%	45	3.3%	68	2.7%
1-2 days	72	6.4%	94	6.8%	166	6.6%
3-4 days	114	10.1%	173	12.6%	287	11.4%
5 plus days	918	81.5%	1066	77.4%	1,984	79.2%
Upside Down wear detected						
No	189	16.8%	326	23.7%	515	20.5%
Yes	938	83.2%	1052	76.3%	1,990	79.4%