

Definition of Acti4 output parameters (ver2007)

LbNr

Subject identification number.

The number must consist of 5 digits (of which the first should not be 0)

Type

Type of interval.

The types of diary activity intervals are:

- A1. Before working hours
- A2. Working hours
- A3. After working hours
- A4. Sleep after working hours
- B1. Before secondary working hours
- B2. Secondary working hours
- B3. After secondary working hours
- B4. Sleep after secondary working hours
- C0. Leisure
- C4. Sleep after leisure
- D. Other (Ill etc.)
- E. Actigraph(s) worn/not worn

The times of these intervals are manually entered into the setup file, which is the input for the Acti4 programme.

'Actigraph(s) worn/not worn' represents an interval in which one or more Actigraphs are not worn. This could be manually filled in into the setup file based on diary information or visual inspection of the activity analysis. In addition, 'not-worn' periods are also detected automatically by Acti4. If no movements are detected during 1½ hour for a non-sleep period the Actigraph is considered not-worn (periods between 10 to 90 minutes are also considered not-worn if a certain amount of movement is detected just before and the orientation deviates less than 5° from horizontal lying)

Weekday

Weekday number of interval (1=Monday).

Start

Start time of interval (dd/mm/yyyy/HH:MM:SS)

Stop

Stop time of interval (dd/mm/yyyy/HH:MM:SS)

WorkDay

If the day includes a working interval (A2 or B2), this parameter is set to 1, otherwise 0.

Time

Length of interval (Stop-Start) in hours (Time = ThighOff+lie+sit+stand+move+walk+run+stairs+cycle+row)

Note that 'Time', the length of the measurement interval 'Type', is the sum of the activities lie, sit, stand, move, walk, run, stairs, cycle, row and ThighOff. If ThighOff, which is the time that the thigh Actigraph is considered not-worn, is an essential part of 'Time', the activity classification (lie, sit,...) may not be representative for the actual period.

HipTrunkOffLS

Length of uncertain periods (h) with 'lie' or 'sit' classification because valid data from both AG hip **and** AG trunk are missing. To differentiate between 'lie' and 'sit', recordings by either the hip or the trunk Actigraph must be available. For all non-sleep intervals these uncertain periods are classified as 'sit' and for sleep intervals as 'lie'.

VrefThighAP

Anterior/posterior reference angle (°) for the thigh accelerometer, which is the angle between the leg axis and the x-axis of the accelerometer. It is calculated as the median value of all recorded reference angles. If no reference positions have been recorded during the measurement, a separate reference angle is estimated from the periods with walking in each analysis interval (the mean ant/pos angle of the leg during walk have been found to 11°). In this case the individual reference angles are used for the analysis (no median).

VrefThighLat

Lateral reference angle (°) for the thigh accelerometer. This is equals the lateral offset of the accelerometers x-axis, which should be close to zero for a correct positioned accelerometer.

ThighOff

Length of periods (h) without valid data from AG thigh (No activity classification possible).

If 'ThighOff' is an essential part of 'Time', the activity classification (lie, sit,...) may not be representative for the actual period.

lie

Length of periods (h) lying.

Lying is detected if the thigh inclination is above 45° and also the hip inclination is above 65° and trunk inclination is above 45° (default values). Also lying is detected if thigh inclination is above 45° and trunk is more than 45° backwards or sideways regardless of any hip inclination value (recordings by hip Actigraph may be missing). Lying also requires that no movement of the thigh in the direction of thigh's longitudinal axis is detected.

sit

Length of periods (h) sitting.

Sitting is detected if inclination of thigh is above 45° and lying is not detected (in previous versions (2013) it was also required that no movement of the thigh in the direction of thigh's longitudinal axis was detected).

stand (still)

Length of periods (h) standing still.

Standing still is detected if inclination of thigh is less than 45° and no movement of the thigh is detected (standard deviation in any direction of the thigh are below 0.1G).

move

Length of periods (h) moving (standing, neither still or walking).

This is a left over activity used if none of the activities lie, sit, stand, walk, run, stairs, cycle or row is detected. It will normally correspond to a standing posture that is neither detected as standing still nor walking.

walk

Length of periods (h) walking.

Walking is detected if the standard deviation in the thigh's longitudinal axis is between .1G and 0.72G (defaults values) and the mean forward/backward angle is less than the (individual) 'stair threshold' angle.

run

Length of periods (h) running.

Running is detected if standard deviation in the thigh's longitudinal axis is above 0.72G (default) (or below 0.72G and step frequency is above 2.5 Hz) and the mean forward/backward angle is less than the (individual) 'stair threshold' angle.

stairs

Length of periods (h) walking/running stairs.

Walking stairs is detected if the standard deviation in the thigh's longitudinal axis is between .1G and 0.72G and the mean forward/backward angle is between the (individual) 'stair threshold' angle and 40°.

cycle

Length of periods (h) cycling.

Cycling is detected if the standard deviation in the thigh's longitudinal axis is above .1G and the mean forward/backward angle is above 40° and the inclination is below 90°.

row

Length of periods (h) rowing.

Rowing is detected if the standard deviation in the thigh's longitudinal axis is above .1G and the mean forward/backward angle is above 40° and the inclination is above 90°.

sleep

Length of periods (h) sleeping.

This is a provisional method for detection of sleep in lying periods (>15 minutes) based on the acceleration by the arm, trunk or thigh. For each second an index S_n is calculated

$$S_n = \exp(-1/\tau) * S_{n-1} + k * A_n,$$

where A_n is the acceleration in n^{th} second and τ (time constant) and k (gain parameter) are constant.

$S_n > 1$ corresponds to awake state and $S_n \leq 1$ to sleep. An upper limit of $\exp(1) = 2.71$ was set for S_n .

Steps

Number of steps for periods with walking/running (incl. stairs).

WalkSlow

Length of periods with walking speed less than selected threshold for slow walking.

WalkFast

Length of periods with walking speed above (or equal) than selected threshold for fast walking (only the activity walk is used for this calculation, periods with run/stairs are not included).

Sit Tmax

Maximum length (h) of sitting period.

Sit P50

50th percentile (median) of sitting duration distribution (h).

Sit T50

Total time (h) of sitting periods longer than median length.

Sit P10

10th percentile of sitting duration distribution (h).

Sit P90

90th percentile of sitting duration distribution (h).

Sit T30min

Total time (h) of sitting periods longer than 30 minutes.

Sit N30min

Number of sitting periods longer than 30 minutes.

NriseSit

Number of transitions from sitting to upright position.

SitLie Tmax

Maximum length (h) of combined sitting/lying period.

SitLie P50

50th percentile (median) of combined sitting/lying duration distribution (h).

SitLie T50

Total time (h) of combined sitting/lying periods longer than median length.

SitLie P10

10th percentile of combined sitting/lying duration distribution (h).

SitLie P90

90th percentile of combined sitting/lying duration distribution (h).

SitLie T30min

Total time (h) of combined sitting/lying periods longer than 30 minutes.

SitLie N30min

Number of combined sitting/lying periods longer than 30 minutes.

NriseSitLie

Number of transitions from sitting/lying to upright position.

Stand Tmax

Maximum length (h) of standing still period.

StandMove Tmax

Maximum length (h) of combined stand/move period.

ArmOff

Length of periods (h) without valid data from AG arm.

If ArmOff is an essential part of **Time**, the arm inclination data may not be representative for the actual period.

IncArm30, IncArm60,...,IncArm150

Length of periods (h) with arm inclination above 30/60/90/120/150°.

Periods with lying are excluded in the calculations.

IncArmMax90

Maximum length (h) of period with arm inclination above 90°.

Median filtering with a window size of 5 seconds is used for the arm inclination, so 1 or 2 seconds with arm inclination below 90° are not recognized. Periods with lying are excluded in the calculations.

IncArmSit30, IncArmSit60,...,IncArmSit150

Length of periods (h) with arm inclination above 30/60/90/120/150° while sitting.

IncArmSitMax90

Maximum length (h) of period with arm inclination above 90° while sitting.

Median filtering with a window size of 5 seconds is used for the arm inclination, so 1 or 2 seconds with arm inclination below 90° are not recognized.

IncArmStandMove30, IncArmStandMove60,...,IncArmStandMove150

Length of periods (h) with arm inclination above 30/60/90/120/150° while standing still or moving.

IncArmStandMoveMax90

Maximum length (h) of period with arm inclination above 90° while standing still or moving.

Median filtering with a window size of 5 seconds is used for the arm inclination, so 1 or 2 seconds with arm inclination below 90° are not recognized.

IncArm30Upright, IncArmUpright60,...,IncArmUpright150

Length of periods (h) with arm inclination above 30/60/90/120/150° while standing still, moving, walking, running or walking stairs.

IncArmUprightMax90

Maximum length (h) of period with arm inclination above 90° while standing still, moving, walking, running or walking stairs.

Median filtering with a window size of 5 seconds is used for the arm inclination, so 1 or 2 seconds with arm inclination below 90° are not recognized.

IncArmPrctile10

10th percentile of arm inclination (°).

Periods with lying are excluded in the calculations.

IncArmPrctile50

50th percentile of arm inclination (°).

Periods with lying are excluded in the calculations.

IncArmPrctile90

90th percentile of arm inclination (°).

Periods with lying are excluded in the calculations.

VrefTrunkAP

Anterior/posterior reference angle (°) for the trunk accelerometer, which is the angle between the trunk axis and the x-axis of the accelerometer. It is calculated as the median value of all recorded reference angles. If no reference positions have been recorded during the measurement, a separate reference angle is estimated from the periods with walking in each analysis interval (the mean ant/pos angle of the trunk during walk have been found to 6°). In this case the individual reference angles are used for the analysis (no median).

VrefTrunkLat

Lateral reference angle (°) for the trunk accelerometer. This is equals the lateral offset of the accelerometers x-axis, which should be close to zero for a correct positioned accelerometer.

TrunkOff

Length of periods (h) without valid data from AG trunk.

If TrunkOff is an essential part of **Time**, the trunk inclination data may not be representative for the actual period. Compare also to the above remarks to **HipTrunkOffLS**

ForwIncTrunkNN (NN=20,30,60,90°)

Length of periods (h) with forward trunk inclination above 20/30/60/90°.

These parameters detect the time in which the inclination of the trunk in the forward plane is above the angles 20, 30, 60 and 90°. It should be noted that is not the same as flexion, which is the forward angle between the pelvis and trunk. The **ForwIncTrunkNN** parameters tell the inclination of the trunk when in a forward position generally as a result of combined flexion and lateral flexion.

ForwIncTrunkMax60

Maximum length (h) of period with forward trunk inclination above 60°.

Median filtering with a window size of 5 seconds (dT=3sec) is used for the trunk inclination, so 1 or 2 seconds with trunk inclination below 60° are not recognized.

ForwIncTrunkSitNN (NN=20,30,60,90°)

Length of periods (h) with forward trunk inclination above 20/30/60/90° while sitting.

These parameters detect the time in which the inclination of the trunk in the forward plane is above the angles 20, 30, 60 and 90°. It should be noted that is not the same as flexion, which is the forward angle between the pelvis and trunk. The **ForwIncTrunkSit** parameters tell the inclination of the trunk when in a forward position generally as a result of combined flexion and lateral flexion.

ForwIncTrunkSitMax60

Maximum length (h) of period with forward trunk inclination above 60° while sitting.

Median filtering with a window size of 5 seconds (dT=3sec) is used for the trunk inclination, so 1 or 2 seconds with trunk inclination below 60° are not recognized.

ForwIncTrunkStandMoveNN (NN=20,30,60,90°)

Length of periods (h) with forward trunk inclination above 20/30/60/90° while standing still or moving.

These parameters detect the time in which the inclination of the trunk in the forward plane is above the angles 20, 30, 60 and 90°. It should be noted that is not the same as flexion, which is the forward angle between the pelvis and trunk. The **ForwIncTrunkStandMove** parameters tell the inclination of the trunk when in a forward position generally as a result of combined flexion and lateral flexion.

ForwIncTrunkStandMoveMax60

Maximum length (h) of period with forward trunk inclination above 60° while standing still or moving. Median filtering with a window size of 5 seconds (dT=3sec) is used for the trunk inclination, so 1 or 2 seconds with trunk inclination below 60° are not recognized.

ForwIncTrunkUprightNN (NN=20,30,60,90°)

Length of periods (h) with forward trunk inclination above 20/30/60/90° while standing still, moving, walking, running or walking stairs.

These parameters detect the time in which the inclination of the trunk in the forward plane is above the angles 20, 30, 60 and 90°. It should be noted that is not the same as flexion, which is the forward angle between the pelvis and trunk. The **ForwIncTrunkUpright** parameters tell the inclination of the trunk when in a forward position generally as a result of combined flexion and lateral flexion.

ForwIncTrunkUprightMax60

Maximum length (h) of period with forward trunk inclination above 60° while standing still, moving, walking, running or walking stairs.

Median filtering with a window size of 5 seconds (dT=3sec) is used for the trunk inclination, so 1 or 2 seconds with trunk inclination below 60° are not recognized.

IncTrunkWalk

Median (°) inclination of trunk during walk.

This parameter could be used for quality assessment of trunk inclination data. Large differences between days for this parameter could indicate incorrect positioning of the trunk Actigraph. The parameter is not calculated if the total walk time is less than 1minute during the period.

AHTime

Length of AH interval (h).

The Actiheart stops recording when the memory is full (440000 beats), which usually happen after 3-4 days. So normally no Actiheart data exists for the last 2-3 days of the Actigraph recordings (when Actheart and Actigraph recording start simultaneous). So normally, for the first number of intervals **AHTime** is equal to **Time**, then when the Actheart stops there is an interval for which **AHTime<Time**, and afterwards no AHTime is found.

NBeat

Number of heartbeats in interval.

PctBeatErr

Percentage of time in interval without valid heart rate data.

Interbeat intervals (IBIs) are regarded erroneous, if they are less than 0.3 sec or more than 1.7 sec or generally, if they deviate more than 15% compared to neighbouring IBIs

For all parameters in the list from **HRmean** and the following, they are not calculated if **PctBeatErr** is higher than 50% for the actual period.

HRmin

Minimum HR (heart rate) in interval.

The minimum heart rate is minimum value for a running average of 10 heart beats throughout the series of heart beats.

HRmax

Maximum (heart rate) in interval.

The maximum heart rate is maximum value for a running average of 10 heart beats throughout the series of heart beats.

HRmean

Mean HR for interval.

The mean HR is calculated as 60 divided by the mean of the IBIs for the interval (abnormal IBIs excluded).

HRsleep

Mean HR during sleep.

HRRmean

HRR (heart rate reserve, %) for interval.

The heart rate reserve (%) is calculated by the formula

$$\text{HRRmean} = 100 * (\text{HRmean} - \text{HRrest}) / (\text{HRmax} - \text{HRrest})$$

If no value for HRmax is found in the Setup file's Info sheet, HRmax is calculated from Age by the formula

$$\text{HRmax} = 208 - 0.7 \cdot \text{Age}.$$

HRoff

Mean HR for periods with AG thigh off.

HRlie

Mean HR for periods with activity lie.

HRsit

Mean HR for periods with activity sit.

HRstand

Mean HR for periods with activity stand still.

HRmove

Mean HR for periods with activity move.

HRwalk

Mean HR for periods with activity walk.

HRrun

Mean HR for periods with activity run.

HRstairs

Mean HR for periods with activity walking/running stairs.

HRcycle

Mean HR for periods with activity cycle.

HRrow

Mean HR for periods with activity row.

HHRoff

Mean HRR (%) for periods with AG thigh off.

HHRlie

Mean HRR (%) for periods with activity lie.

HHRsit

Mean HRR (%) for periods with activity sit.

HHRstand

Mean HRR (%) for periods with activity stand still.

HHRmove

Mean HRR (%) for periods with activity move.

HHRwalk

Mean HRR (%) for periods with activity walk.

HHRrun

Mean HRR (%) for periods with activity run.

HHRstairs

Mean HRR (%) for periods with activity walking/running stairs.

HHRcycle

Mean HRR (%) for periods with activity cycle.

HHRrow

Mean HRR (%) for periods with activity row.

HHR 1, HHR 2,...,HHR 100

HRR_n is the length of time (h) in which the HRR value is less than n%. Only beats that are not error classified are considered in the calculation. The total time of non-error classified beats corresponds to the HRR_100 value, which is generally less than the **AHtime**.