evinlo

EVINLO EXPLAINERS

Body signals, explained

What the Body signals page shows about your night, what it counts, what it never counts, and why each value sits where it does.

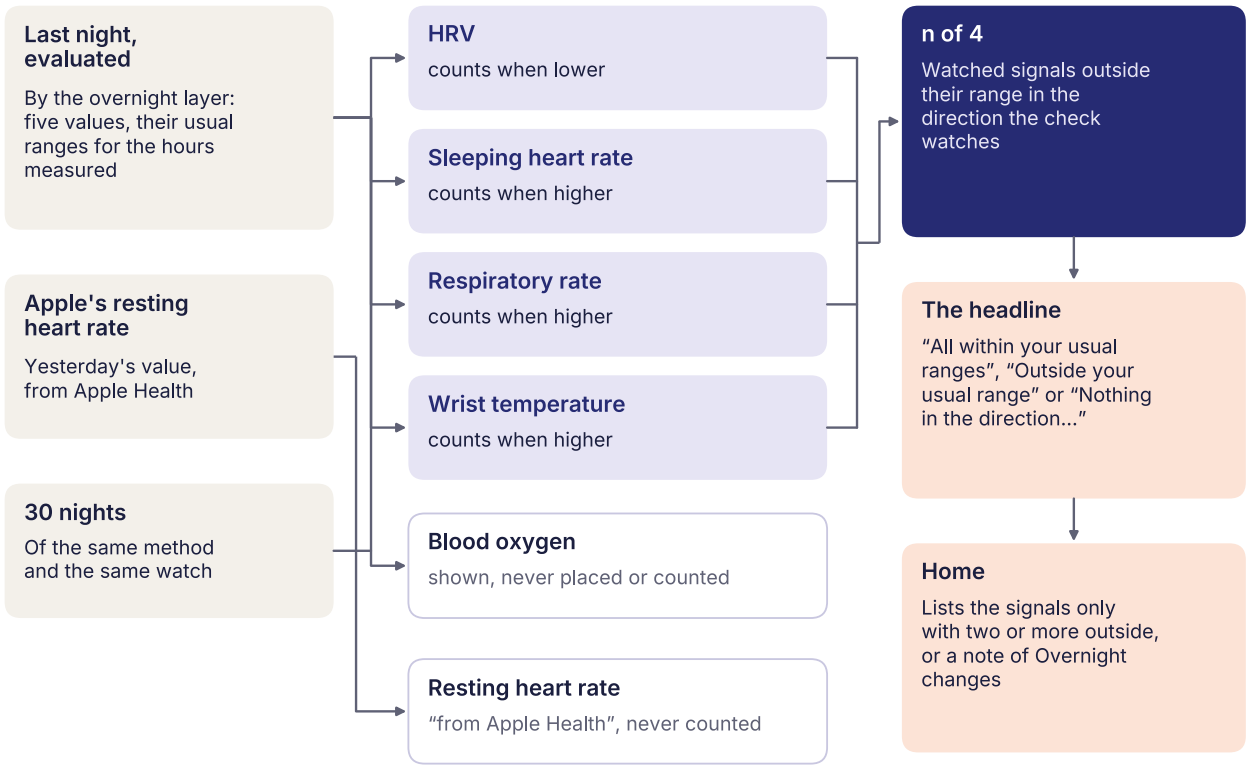


ALGORITHM
Body signals 1.0.0

WRITTEN
October 2026

The one-minute version

The **Body signals** page shows five things your Apple Watch recorded while you slept, each next to **your usual range**: overnight HRV (how much the time between heartbeats varies), sleeping heart rate, respiratory rate, wrist temperature and blood oxygen. At the top, one number says how many are outside their range in the direction that matters, for example “0 of 4”.



The page in one picture. The overnight layer hands over last night’s values and ranges. Four signals are watched, each in one direction; blood oxygen and Apple’s resting heart rate are shown and never counted. The count of watched signals outside their range decides the headline, and Home lists the signals only when two or more are outside.

IN SHORT

- **Five values, your own ranges.** Each value is last night’s, and its range is your usual, from your nights of the last 60 days (for HRV and the sleeping heart rate, your usual for the hours of the night that were measured).
- **“n of 4” counts one direction only:** a lower HRV, a higher sleeping heart rate, respiratory rate or wrist temperature. A value outside on the other side is named plainly and not counted.
- **Blood oxygen is shown, never judged.** It gets a range and a chart, no “above” or “below”, and it never counts.
- **Apple’s resting heart rate is not Evinlo’s sleeping heart rate.** It is shown as it is, always “from Apple Health”.
- **A missing value says why,** in what Evinlo found, and never claims your watch cannot measure something.

What goes in

The page measures nothing itself. Everything on it comes from the **overnight layer**, the part of Evinlo that turns what your watch recorded overnight into nightly values and usual ranges (see “The overnight layer, explained”).

What	From	What the page does with it
Each signal’s value, its usual range, and how far its usual is known	The overnight layer	The value, the range, where it sits, the count
How many readings or recordings a value rests on, and the HRV method	The overnight layer	A quiet line under the value, “Limited data”
The values of the 30 nights up to last night, of the same method and the same watch	The overnight layer’s nightly values	The chart under each signal
Apple’s resting heart rate of the day before, and its own usual	Apple Health, read fresh on every refresh	A row “from Apple Health”
Why a signal or the whole night has no value	The overnight layer and the sleep section	The note in its place
The status of Overnight changes	Overnight changes	A row that leads to that page

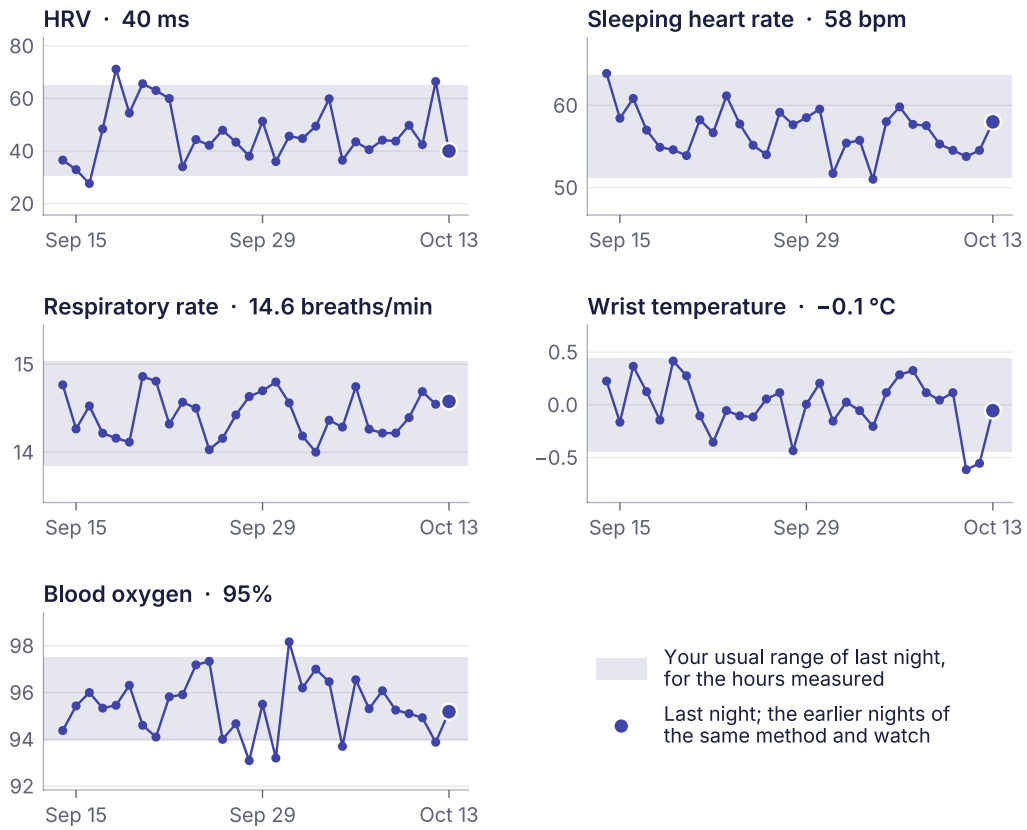
How it works, step by step

Step 1: each value, with your usual range

Each signal shows last night’s value and, under it, your usual range (“Usual 51–64 bpm”). Behind the range is one rule: the middle of your nights of the 60 days before, plus and minus 2 spreads. A **spread** is how much your nights usually vary around that middle (1.4826 times their median absolute deviation, a robust cousin of the standard deviation). For HRV and the sleeping heart rate the range is also moved for the hours of the night that were measured, because both change over the first hours of sleep. The chart under each signal shows the 30 nights up to last night, with **last night’s** range as the band.

How each value is shown:

- **HRV** in milliseconds, as RMSSD (how much each interval between two heartbeats differs from the next), worked out from the night’s recordings. The Health app shows SDNN, another measure of the same recordings, so its number differs.
- **Sleeping heart rate**, the average while you were asleep. It is not Apple’s resting heart rate, which is shown in its own row under it.
- **Respiratory rate** in breaths per minute.
- **Wrist temperature only as a difference** from your usual (“−0.1 °C”), never as a temperature. That is also why it has no value at all until its usual exists. The chart shows the earlier nights against last night’s usual.
- **Blood oxygen** in percent.



Maya's five signals over the 30 nights up to 13 October, each with the usual range of last night. Her last night sits inside every range. Maya is a synthetic person (see "A worked example").

A quiet line under the value says what it rests on: "From 4 one-minute recordings by Apple Watch while you slept", "Average of 88 readings while you were asleep". It adds "Limited data last night" for an HRV value from 2 recordings (or fewer than 12 of Apple's own readings, or SDNN), and "Early range, from …" with the number of nights while a range rests on fewer than 28. When the range was moved by half a spread or more for the hours measured, it reads "Usual for the hours measured: …". For 14 nights after Apple's own HRV readings take over, a note says that the level differs a little from before. A chart holds only nights of the method and the watch the value comes from.

Step 2: where it sits, and what counts

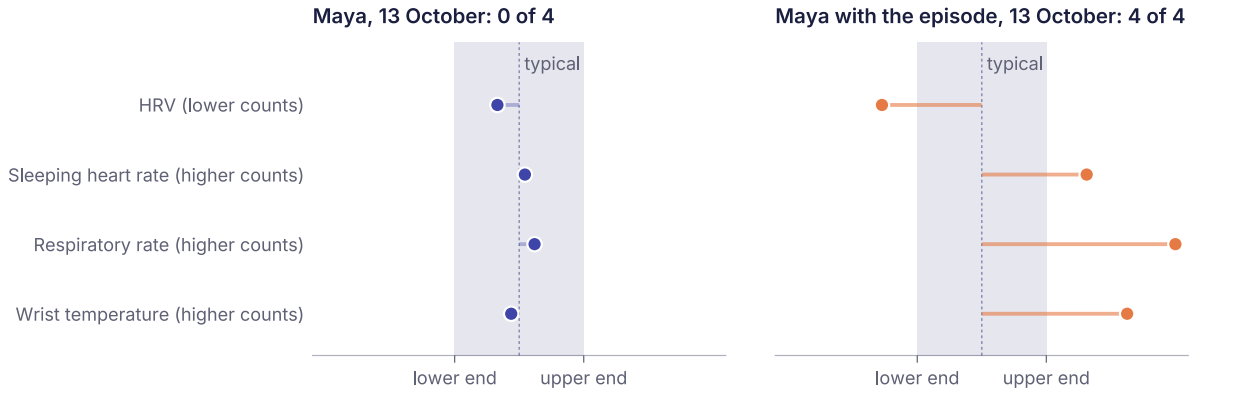
A value is **below**, **within** or **above** your usual range; on the range's end it is still within. The label next to it says so ("Usual", "Above usual", "Below usual"), and it turns warm only in the direction the check for overnight changes watches:

Signal	Counts when	On the other side
HRV	below its range	"Above usual", plain, not counted
Sleeping heart rate	above its range	"Below usual", plain, not counted
Respiratory rate	above its range	"Below usual", plain, not counted
Wrist temperature	above its range	"Below usual", plain, not counted
Blood oxygen	never	no label at all

The **count** at the top is the watched signals outside their range in that direction, out of the watched signals that have a range: “0 of 4”, or “0 of 3” with a watch that records no wrist temperature. The headline follows it:

- **“All within your usual ranges”** only when every watched signal is within its range;
- **“Outside your usual range”** when the count is 1 or more;
- **“Nothing in the direction the check watches”** when none counts but one is outside on the other side, with a line that names it (“Outside its usual range, in a direction the check doesn’t count: heart rate variability”).

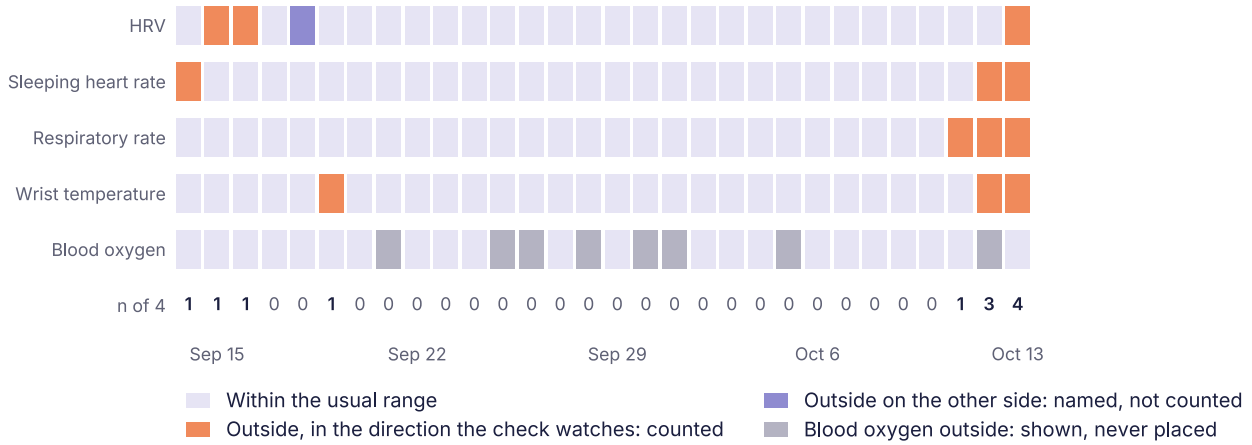
Under the headline, a chart puts the four watched signals on **one shared scale**: each range is stretched to the same band, so you can compare them. A dot outside the band is warm only in the watched direction. The chart stops at three times the distance from your typical value to an end.



Each usual range stretched to the same band; the chart stops at three times the distance from the typical value to an end

The shared scale for Maya on 13 October, and for Maya with an illness-like episode the generator added to the same nights. Her respiratory rate with the episode is 3.4 times as far from her typical value as the end of her range, so it stops at the chart’s edge.

Night by night, the count stays low. One signal outside its range now and then is common, and the page says so in the footer of that chart.



The 30 nights up to 13 October of Maya with the episode: each signal, whether it was outside its range and on which side, and the count. Blood oxygen strays outside its range often, from measurement noise above all, and never counts.

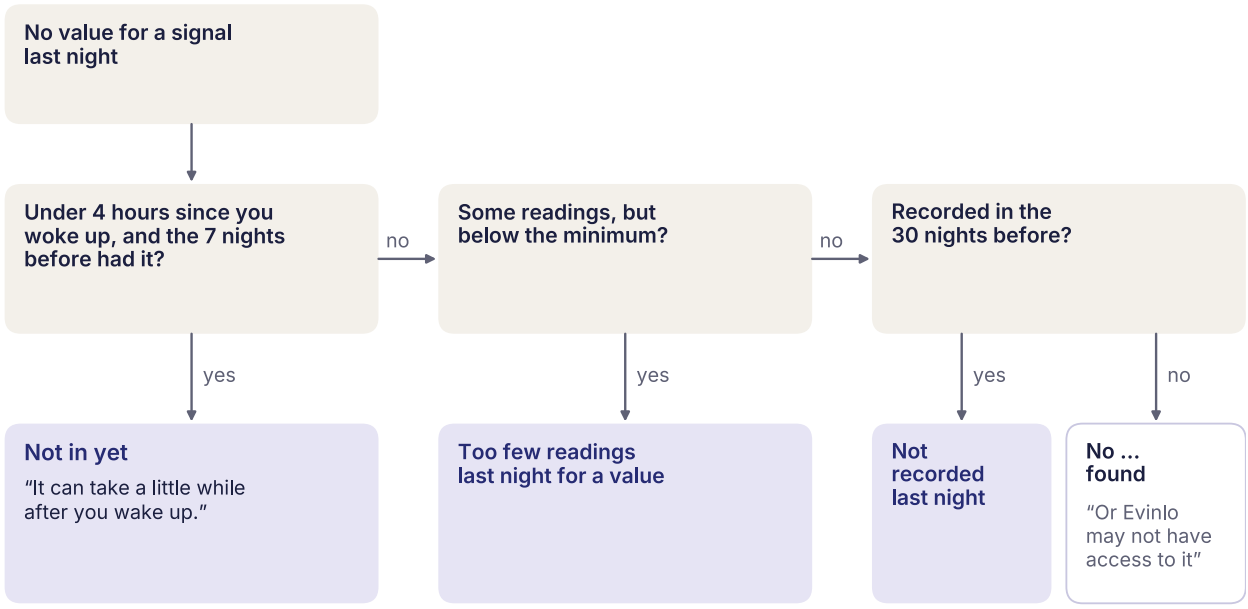
In these 30 nights, 4 nights had 1 of 4 before the episode began on 11 October. On 18 September her HRV was above its range: the count stayed 0, and the headline read “Nothing in the direction the check watches”. Blood oxygen was outside its range on 8 of the 30 nights without ever counting.

Blood oxygen is shown, never judged. Its nightly average rests on few readings, so much of what moves it is measurement noise. The page shows the value, your usual range and the chart, with no position label; it is not in the count, not in the shared chart, not part of Overnight changes and not part of Readiness.

Apple's resting heart rate is Apple's daily estimate of the day before, labelled "Resting heart rate from Apple Health, yesterday". It is shown under the sleeping heart rate. Only on a night without any sleeping heart rate does it stand in that place, with its own usual range and the line "Yesterday's value from Apple Health. It doesn't count when Evinlo looks for overnight changes."

Step 3: when a signal has no value

A signal without a value says what Evinlo found, in this order:



How the page decides what to say in place of a missing value. Apple Health does not tell an app whether access was turned off, so the last answer always adds that Evinlo may not have access.

- **Not in yet:** within 4 hours of waking up, when at least one of the 7 nights before had the signal. "It can take a little while after you wake up."
- **Too few readings last night for a value:** some readings, but fewer than a value needs (the sleeping heart rate, for example, needs 20 readings in 3 different hours of the night).
- **Not recorded last night:** none last night, some in the 30 nights before.
- **No ... found:** none in the 30 nights before either. The page says where the signal comes from ("It needs an Apple Watch with a temperature sensor, worn to bed with Sleep Focus on.") and adds "Or Evinlo may not have access to it.", with a row to Apple Health in Settings.
- **Getting to know your usual:** wrist temperature has a value only as a difference from its usual, so in the first week, and for 7 nights after a new watch, it shows how many earlier nights there are so far.

When the **whole night** has no body signals, the page says why instead: the night isn't over yet, it hasn't reached the iPhone, no sleep was recorded, it came from another sleep tracker ("Body signals need a night recorded by Apple Watch."), only part of it was recorded, it was entered by hand, it was under 3 hours of sleep, or no overnight signal was found at all. While the usual ranges are still being worked out, the page shows last night's plain values first, under "Measured last night".

Step 4: Body tab and Home

The **Body tab** shows the same count and headline in a row, with a small version of the shared chart, and leads to the page. **Home** names the signals only when it matters: when two or more watched signals are outside their range in the watched direction, or when Overnight changes noted the night. Otherwise it shows one calm line, such as “Your overnight signals were within your usual ranges.” or “One overnight signal was outside its usual range. One alone is common.” Blood oxygen and a value on the other side never appear on Home.

A worked example

Meet **Maya**. She is a synthetic person: the app’s generator made her nights and days, and no part of her comes from a real person. This is her page at 16:30 on Tuesday, 13 October 2026, for the night that ended that morning.

Signal	Last night	Usual	Where	Counted?
HRV	40 ms	31 to 65 ms	within	no
Sleeping heart rate	58 bpm	51 to 64 bpm	within	no
Respiratory rate	14.6 breaths/min	13.8 to 15.0	within	no
Wrist temperature	−0.1 °C	−0.4 to +0.4 °C	within	no
Blood oxygen	95%	94 to 98%	no label	never

The count is **0 of 4** and the headline “All within your usual ranges”. Her HRV line reads “From 4 one-minute recordings by Apple Watch while you slept”; her sleeping heart rate “Average of 88 readings while you were asleep”, followed by Apple’s resting heart rate of the day before, 57 bpm, “from Apple Health”. The respiratory rate rests on 45 readings, blood oxygen on 11, wrist temperature on Apple’s one value of the night.

The same night with an illness-like episode. For this the generator raised her heart rate, breathing and wrist temperature and lowered her HRV, on the third night of four. The page reads:

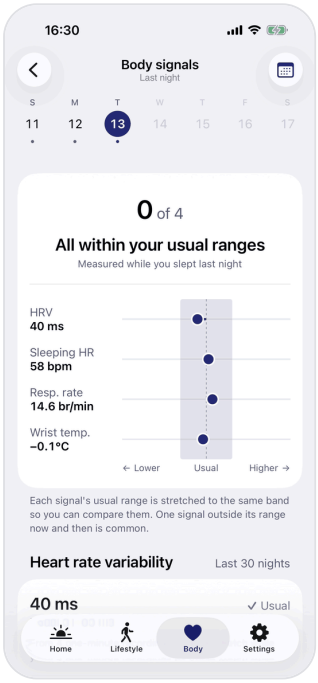
Signal	Last night	Usual	Where	Counted?
HRV	23 ms	31 to 65 ms	below	yes
Sleeping heart rate	68 bpm	51 to 64 bpm	above	yes
Respiratory rate	16.6 breaths/min	13.8 to 15.1	above	yes
Wrist temperature	+0.9 °C	−0.4 to +0.4 °C	above	yes

The count is **4 of 4**, “Outside your usual range”. Every watched dot on the shared scale is warm, the respiratory rate at the chart’s edge. Because two or more are outside, Home lists them, and Overnight changes, which reads the same values, says “Several signals unusual” (see “Overnight changes, explained”).

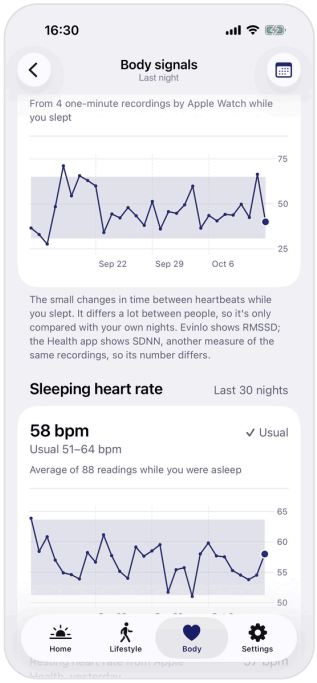
A new person in their first week sees “Getting to know your usual” with “4 of 7 earlier nights”: the values are there, the ranges are not yet.

What you see in the app

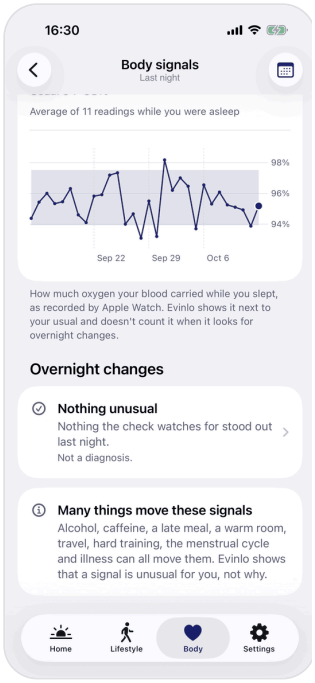
These are the screens of that afternoon in the app's synthetic data mode: Maya's page from top to bottom, then the episode, a new person and the Body tab.



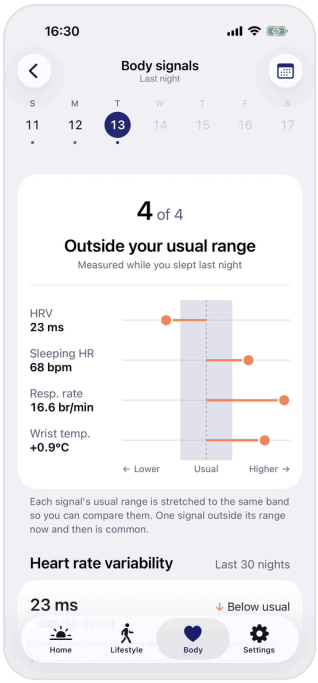
The count, the headline and the shared chart.



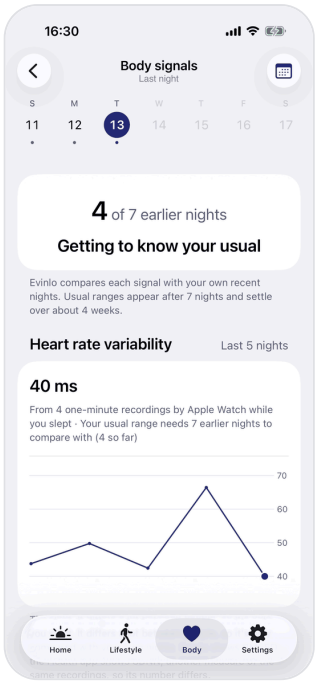
HRV and the sleeping heart rate: value, range, what it rests on, 30 nights.



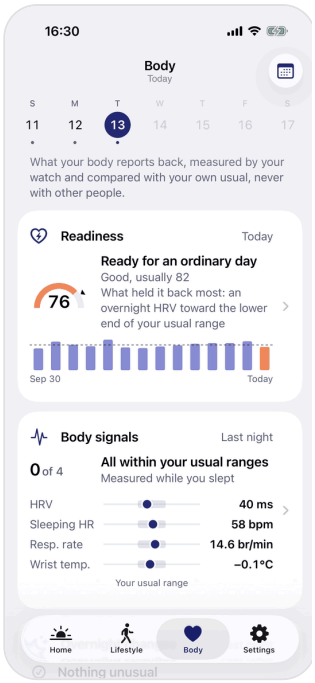
Blood oxygen without a label, the link to Overnight changes.



With the episode: "4 of 4", warm dots.



The first week: "4 of 7 earlier nights".



The Body tab, with the same count.

Honest limits

- **A watch estimates.** Optical heart rate depends on fit and movement; HRV often rests on four or five one-minute recordings; wrist temperature is skin temperature, moved by the room and the bedding; blood oxygen rests on a few readings.
- **“Outside your usual range” is a comparison, not a judgement.** A value outside your range says that it is unusual for you, not that it is good or bad, and not why. Alcohol, caffeine, a late meal, a warm room, travel, hard training, the menstrual cycle and illness can all move these signals.
- **One signal outside its range now and then is common.** With four watched signals, a night with one of them outside happens often, which is why Home stays calm about it.
- **Your usual follows you.** A slow, lasting change becomes the new usual over weeks.
- **Signals need your watch at night.** Without a watch worn to bed with sleep tracking on, or with a sleep tracker other than Apple Watch, there are no body signals.
- **Maya is generated.** Her nights are calmer than a real person’s.

For the experts

Version and scope

`BodySignalsAlgorithm.version` is **1.0.0** and covers what is shown: the states of each signal, the values and ranges as displayed, the histories and availability. The values, ranges and distances themselves are the overnight layer’s (`OvernightAlgorithm.version` 1.0.0).

Parameters and fixed rules

Rule	Value	In code
Width of the range shown, and the line between within and outside	median ± 2 spreads	`OvernightParameters.usualRangeScales` 2.0
“Usual for the hours measured”	from an allowance of 0.5 spreads	`allowanceNoteScales` 0.5
“Getting to know your usual”; “Early range, from n nights”	below 7 nights; 7 to 27 nights	`baselineMinimumNights` 7, `baselineEstablishedNights` 28
“Limited data”	HRV from 2 recordings, fewer than 12 of Apple’s readings, or SDNN	`beatSeriesGood` 3, `appleRMSSDGood` 12
The note after Apple’s readings take over	14 nights	`methodChangeNoteNights` 14
“Not in yet”	within 4 hours of waking, when one of the 7 nights before had the signal	`notInYetHours` 4, `OvernightTimeline.notInYetLookbackNights` 7
“No … found”	nothing in the 30 nights before	`recentDataDays` 30

Rule	Value	In code
The chart	the 30 nights up to the night shown (HRV: of one method; wrist temperature: of one watch)	`PipelineParameters.signalHistoryNights` 30
Plain values while ranges are worked out	the night and the 7 before	`PipelineParameters.valueStageNights` 7
Days with body signals	the last 365	`PipelineParameters.bodyHistoryDays` 365
The direction that counts	HRV below; sleeping heart rate, respiratory rate, wrist temperature above; blood oxygen and resting heart rate never	`HealthMetric.illnessDirection`
The shared scale	±1 at the ends of the range, stops at ±3	`UsualRange.relativeOffset(of:)`, `SignalDeviationChart.limit` 3
Home lists the signals	from 2 outside in the watched direction, or with a note of Overnight changes	`HealthSnapshot.notableSignals`

Formulas

With *v* the value, *t* the typical value, and [*l*, *u*] the range shown (for HRV and the sleeping heart rate, for the hours measured; for HRV in ms, for wrist temperature as a difference from the usual):

$$\text{position} = \begin{cases} \text{below} & v < l \\ \text{above} & v > u \\ \text{within} & \text{otherwise} \end{cases} \qquad \text{shared scale} = \begin{cases} \dfrac{v-t}{u-t} & v \geq t \\ \dfrac{v-t}{t-l} & v < t \end{cases}$$

With HRV's median *m* and spread *s* in ln ms and its allowance *a* (the shift for the hours measured): the value shown is $e^{\bar{x}}$, the range $[e^{m+a-2s},\ e^{m+a+2s}]$ and the typical value e^{m+a}. For wrist temperature, the value shown is the night's temperature minus the median, and the range is $[a-2s,\ a+2s]$ around 0.

$$n = \#\{\text{watched signals with a range whose position is the watched direction}\}$$

The order of operations

1. **Stage C0** of the day pipeline reads the night and the 7 before and shows their plain values: "Measured last night" (`BodySignalsEngine.bodySignals(… rangesArePending: true)`). Wrist temperature waits, because it is only ever a difference.
2. **Stage C1** evaluates the night against its 60 days (`OvernightEngine.signals(for:)`) and builds the page: each signal's reading as shown, its range, how far the usual is known, the provenance, the method note, the 30-night history (`OvernightEngine.history(for:)`), Apple's resting heart rate, and the reason for each missing signal.
3. **Snapshot.** The page, the Body tab and Home read the same `BodySignals` from the day's `HealthSnapshot`, so they never disagree.

Edge cases

- **A value on the end of its range** is within it.
- **A watch without wrist temperature or blood oxygen:** those two read "No … found", and the count is "of 3".

- **A sleeping heart rate without a usual range yet** is not replaced by Apple's resting heart rate; Apple's value stands in only when the night has no sleeping heart rate at all.
- **A new watch:** wrist temperature restarts its usual and says so ("New watch: Evinlo is getting to know your usual wrist temperature again."); every other signal carries on.

Where it lives in the code

What	Where
The version and the engine	`Packages/EvinloKit/Sources/EvinloAlgorithms/Contract/BodySignalsContract.swift`
Building the page from the evaluated night	`EvinloAlgorithms/BodySignals/BodySignalsBuilder.swift`
How a value and its range are shown (ms, a difference in °C)	`EvinloAlgorithms/BodySignals/SignalDisplay.swift`
The model: signals, the count, the watched direction	`Packages/EvinloKit/Sources/EvinloModels/BodySignals.swift`, `Measurements.swift`
What Home lists	`Packages/EvinloKit/Sources/EvinloModels/Snapshots.swift` (`notableSignals`)
The page, its words and its shared chart	`App/Evinlo/Features/Body/Signals/SignalsDetailView.swift`, `App/Evinlo/Data/Wording/BodySignalsWording.swift`, `App/Evinlo/DesignSystem/Charts/SignalDeviationChart.swift`
The tests	`Packages/EvinloKit/Tests/EvinloAlgorithmsTests/BodySignals/`, `Packages/EvinloKit/Tests/EvinloModelsTests/BodySignalsModelTests.swift`

What the validation checks

The evaluation tool (`Tools/EvinloEval`) replays every night through the same day pipeline as the app and reports aggregates only, never a level of a signal. Its hard guardrails fail on any data: identical evaluations, no change when later nights are taken away, no value that is not a number, no usual range across watches or HRV methods or from fewer than 7 nights, no value for a night without body signals. Its warnings are bands for a person's own data: how often each signal is outside its range, each side on its own; how often any of the five is; how many usable nights have a value; the shift after a new watch; and how often Home would show a body-signal line. On synthetic people it checks that a new person has no range before the eighth night, that a new watch restarts wrist temperature for exactly 7 nights, and that nights from another tracker have no value.

References

- Leys C. et al., "Detecting outliers: do not use standard deviation around the mean, use absolute deviation around the median", *Journal of Experimental Social Psychology* 49(4), 2013.
- Shaffer F., Ginsberg J. P., "An overview of heart rate variability metrics and norms", *Frontiers in Public Health* 5:258, 2017.
- Apple's support articles on overnight vitals and on nightly wrist temperature. The complete rules: docs/scoring.md, "Body signals".

Spotted something unclear or wrong, or want to improve a rule? Evinlo is open source, and every rule can be changed through a proposal and a replay. Start at **evinlo.com/contribute**.