kubios

KUBIOS HRV SCIENTIFIC

Heart rate variability (HRV) analysis software for scientific research and professional use

The gold-standard HRV software

Kubios HRV is a scientifically validated software and is being used roughly at 1800 universities in 149 countries. The key publications related to the software and its pre-processing algorithms are listed at kubios.com/publications. Kubios HRV software has been used in over 5900 scientific publications.

Designed for research and professional use

Kubios HRV Scientific provides the most detailed HRV analysis on the market. In addition, ECG waveform, ANS function, and training data analytics are supported. Reliability and accuracy of HRV results is guaranteed by robust beat detection, noise handling and beat correction algorithms.

Supports your measurement device

Kubios HRV Scientific is compatible with most of the HR monitors on the market, with several commonly used electrocardiogram (ECG) devices, and with certain photoplethysmogram (PPG) devices. In addition, the software supports Kubios HRV mobile app measurements.

FEATURES

Operating system

- Win (10/11) and macOS (Monterey/ Ventura/Sonoma), 64-bit systems

Kubios HRV mobile app

- Analyze custom measurements made with the Kubios HRV app
- Compatible with Polar (H10 and Verity Sense) and other Bluetooth HR sensors supporting RR interval data

Supported devices

kubios.com/supported-devices

- **HR monitors**: Polar, Garmin, Suunto etc. (RR data)
- **ECG devices**: Actiheart 5, AliveCor Kardia, Biopac, Bittium Faros, Mindfield MindMaster, Movesense, Shimmer, etc. (ECG data)
- **PPG devices**: Empatica E4, HeartMath emWave, Scosche Rhythm24, etc. (PPG/IBI data)
- Supported file formats include EDF/EDF+, Cardiology XML, ISHNE Holter ECG, Biopac ACQ3, Physionet MIT, FIT and custom text files
- Supports small animal HRV data

Pre-processing

- Built-in beat detection for ECG/PPG
- Automatic noise detection and beat correction algorithms
- Optimal trend removal

HRV analysis

- Analyze specified time periods or process the whole recording using time-varying analysis
- Parasympathetic (PNS) and sympathetic nervous system (SNS) indexes for stress and recovery monitoring
- Time-domain, frequency-domain, and nonlinear HRV parameters (over 40 parameters)
- Respiration rate (RESP) estimate

ECG waveform analysis

- QRS duration, QT and QTc times, and P, Q, R, S and T wave amplitudes for specified time periods

ANS function analysis

- Valsalva ratio, HR response to deep breathing, and 30:15 ratio for head-up tilt challenge

Training data analysis

- Detailed performance metrics (HR, RESP, TRIMP, ventilatory thresholds, EE and VO2) and heart rate recovery

Reports and results export

- HRV analysis (PDF | CSV | "SPSS friendly" CSV)
- ECG waveform analysis (PDF | CSV | "SPSS friendly" CSV)
- ANS function analysis (PDF | CSV)
- Training data analysis (PDF | CSV)
- ECG printout (PDF report)
- Analysis session (Matlab MAT)

Pricing and licensing policy

- A single user, 1-year subscription license. Pricing available at product page (academic pricing available)

Product page and User's Guide

kubios.com/kubios-hrv-scientific

(user's guide, release notes, FAQ, etc.)

Contact Sales or Support

sales@kubios.com

support@kubios.com

HRV MEASUREMENT DATA

Data from your device

- Make sure that your device is able to record RR/IBI, ECG or PPG data and make a recording with your device
- Export the data from your device in any of the supported file formats including:
  1. FIT (common format for storing RR and IBI data)
  2. Custom formatted text and CSV files
  3. European data format (EDF/EDF+)
  4. Biopac ACQ3 format
  5. Cardiology XML format etc. (please see User's Guide for full list of supported formats)
- Direct export from Polar Flow is available
- Not sure if your device or data is supported?
  → Please contact our support

NOTE: Supports also small animal HRV data

Kubios HRV mobile app

- Requires a Bluetooth HR sensor providing beat-to-beat RR data. Recommended sensors:
  - **Polar H10** → RR, ECG and ACC data available in online mode
  - **Polar Verity Sense** → PPI, PPG and ACC data

GET IT ON Google Play Download on the App Store

Kubios HRV mobile app (continued)

- Follow these steps to make new custom measurements
  1. Connect your sensor with the app
  2. Choose data channels and recording mode (online/offline mode available for H10 only)
  3. Provide subject information (if applicable)
  4. Perform the measurement and save it
  5. Download your measurements from Kubios Cloud into your computer using Kubios Cloud sync and analyze them

Note: Android app or offline recording mode is recommended for longer-term recordings (> 2 hours)

Tutorial video: https://youtu.be/28qjeTBCM1M

PRE-PROCESSING FEATURES

Beat detection

- Built-in QRS detector for accurate detection of ECG R-waves
- Built-in pulse wave detector for accurate detection of beats from PPG data
- Tools for manual editing of beat detections

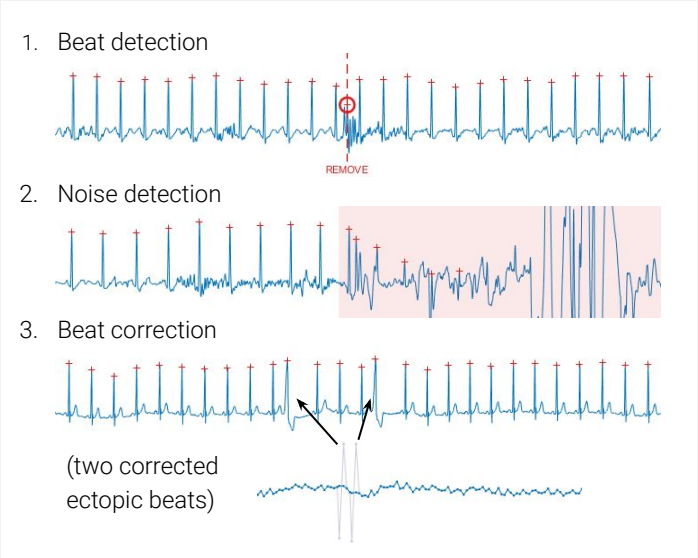
Noise detection

- Automatic noise detection to exclude noisy data periods from HRV analysis
- Noise detection level can be adjusted and noise markings can be manually edited

Beat correction

- Automatic beat correction algorithm for correcting missed, extra and misaligned beats from RR interval time series
- The algorithm was validated using the MIT-BIH arrhythmia database, showing 97.0% accuracy in detecting ectopic beats and 99.9% accuracy in identifying normal beats

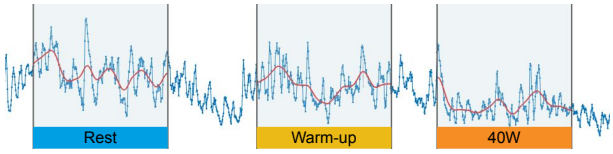
In addition, very low frequency trend components are removed from RR data (using a smoothness prior's method) in order to make HRV analysis parameters sensitive to short term variability.



HRV ANALYSIS FEATURES

Analysis modes

1. Analysis samples: Analyze data at defined time intervals (number of samples and their duration easily editable)

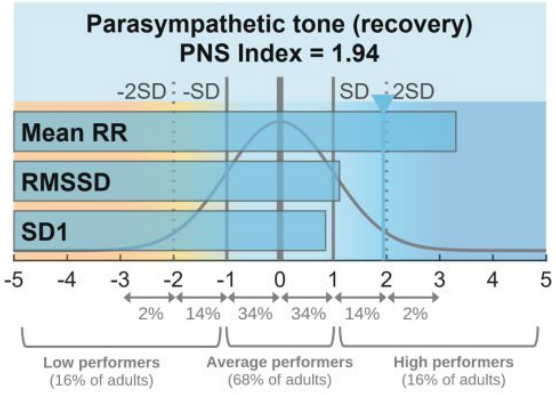


2. Time-varying analysis: Analyze the entire recording in a moving window of your choice to assess time trends of the HRV parameters, e.g. to evaluate stress and recovery during a 24-hour recording

PNS and SNS indexes

- Proprietary indexes for parasympathetic (PNS) and sympathetic nervous system (SNS) activities. These indices have been scaled to normal values in the adult population and thus allow a straightforward interpretation of stress and recovery

  → PNS index at rest is between -1 and 1 for 68% of adults. A high PNS index is an indication of good health, physical fitness, and good readiness (physiological recovery)



HRV analysis parameters

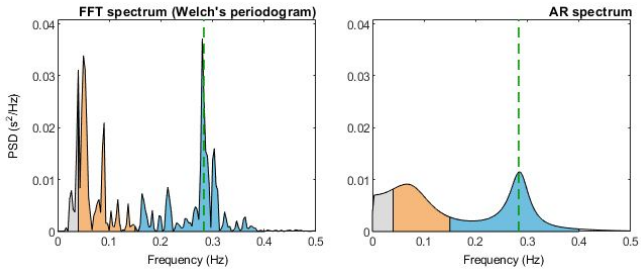
Time-domain HRV parameters include

- Mean RR, mean HR, min HR, max HR
- SDNN, RMSSD, pNN50 (adjustable threshold), HR deceleration (DC), HR acceleration (AC)
- HRV triang. index, TINN, and Baevsky's stress index
- Longer term indexes SDANN and SDNN index

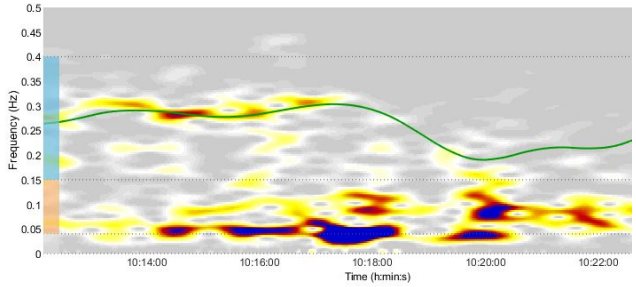
HRV analysis parameters (continued)

Frequency-domain HRV parameters are calculated from Welch's (or Lomb-Scargle) periodogram as well as from a parametric AR spectrum and include:

- VLF, LF and HF peak frequencies (Hz)
- VLF, LF and HF band powers and total power (ms^2)
- LF and HF powers in normalized units (n.u.)
- LF/HF ratio

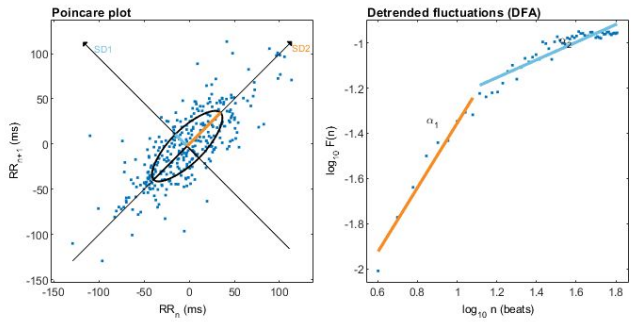


- Respiratory rate (RESP) estimate, utilizing both HRV and ECG waveform data (ECG is used when available). Respiration rate is an important parameter in exercise physiology, in reliable respiratory sinus arrhythmia (RSA) component estimation, and in individual resonance frequency assessment
- Spectrogram with "Fire" colormap, a graphical illustration of dynamic changes in HRV frequency components



Nonlinear HRV parameters include

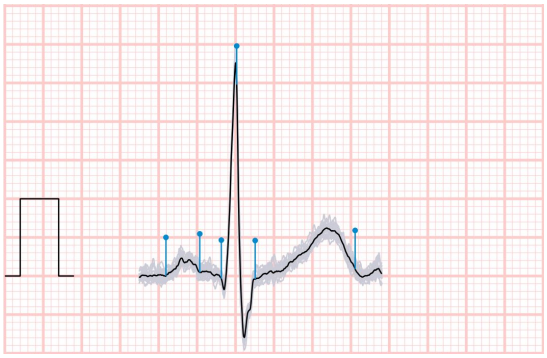
- Poincare plot (SD1, SD2, and SD2/SD1)
- Approximate (ApEn) and Sample Entropy (SampEn)
- Detrended fluctuation analysis (DFA)
- Correlation dimension (D2)
- Recurrence plot analysis (RPA)
- Multiscale entropy (MSE)



ECG WAVEFORM ANALYSIS

Analysis features

- Waveform analysis is carried out for the defined time intervals (analysis samples)
- Parameters include QRS complex duration, QT and QTc interval times, and P, Q, R, S and T wave amplitudes
- Parameters are extracted from an average ECG waveform (selection criteria for averaged beats can be adjusted)
- ECG waveform fiducial points can be manually edited (when necessary)

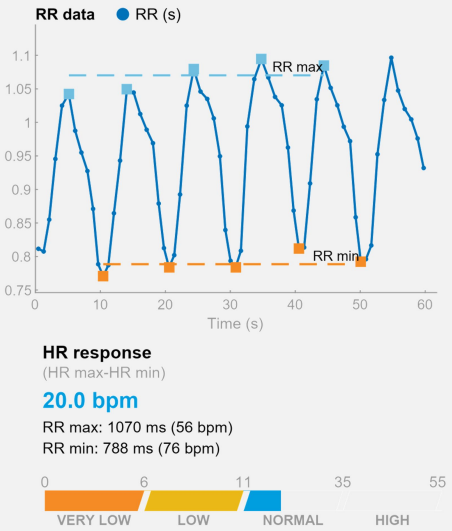


Not for clinical use

ANS FUNCTION ANALYSIS

Analysis features

- Analysis of standard autonomic nervous system (ANS) function tests (Ewing tests)
- Supported tests:
  - → Valsalva maneuver
  - → Deep breathing challenge
  - → Head-up tilt
- Valsalva ratio, HR response to deep breathing, and 30:15 ratio for head-up tilt challenge, all represented using a four-zone model based on normal values
- Additional deep breathing scores include E-I, E/I, resting HR, PNS index, RMSSD, and RSA magnitude
- Additional head-up tilt scores include mean HR, PNS index, RMSSD, SDNN, LF & HF powers, and RESP for supine and upright positions



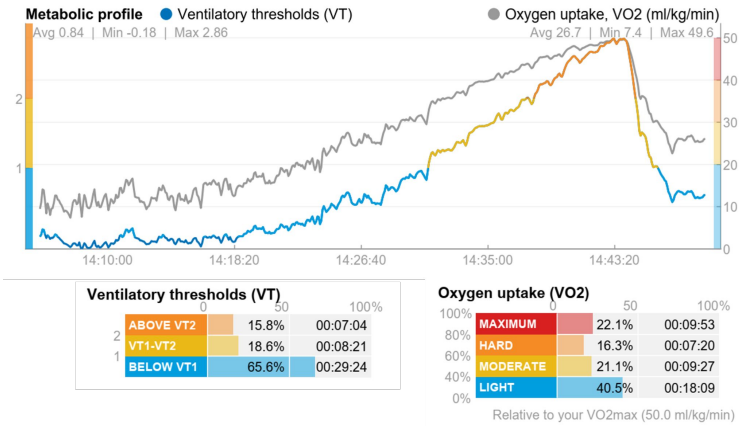
For more information, please visit: kubios.com/about-autonomic-nervous-system-function-analysis

Not for clinical use

TRAINING DATA ANALYSIS

Analysis features

- Heart rate (HR): Instantaneous values (at 5-sec intervals) and HR zones relative to person's HR max or HR reserve
- Respiration rate (RESP): instantaneous values and zones in breaths/min
- Training intensity and volume (TRIMP): instantaneous values (TRIMP/min), intensity zones, and training load accumulation
- Ventilatory threshold (VT) estimate based on HR, RESP and DFA-alpha1: Instantaneous values and VT zones
- Oxygen uptake (VO2): Instantaneous values and zones in ml/kg/min
- Heart rate recovery (HRR): Automatic detection of recovery period and HRR at 60s, 120s and 300s increments as well as fast 30s HRR (T30)



For more information, please visit: kubios.com/about-sport-and-exercise-analysis

Kubios Oy - www.kubios.com
Product page: www.kubios.com/hrv-scientific

Contact Sales: sales@kubios.com
Contact Support: support@kubios.com

REPORTS AND EXPORTING OPTIONS

HRV analysis results

- PDF report with detailed HRV analysis results and graphics (multi-page report)
  → One page per analysis sample
  → Time-varying analysis results on last page
- CSV export with all the analysis results (numeric values) within a structured text file. The CSV file can be opened e.g. in Excel, Sheets or Numbers
- Matlab MAT file export for saving the analysis session and the results. Previously performed analysis session can be reopened by opening the MAT file, which enables an easy way to change analysis settings and reanalyse the data
- ”SPSS friendly” batch file export to save analysis results into a CSV file, which can be opened in Excel or imported into SPSS.

ECG printout

- PDF report with the ECG signal (single lead) on a standard paper ECG layout (multi-page report)

ECG waveform analysis results

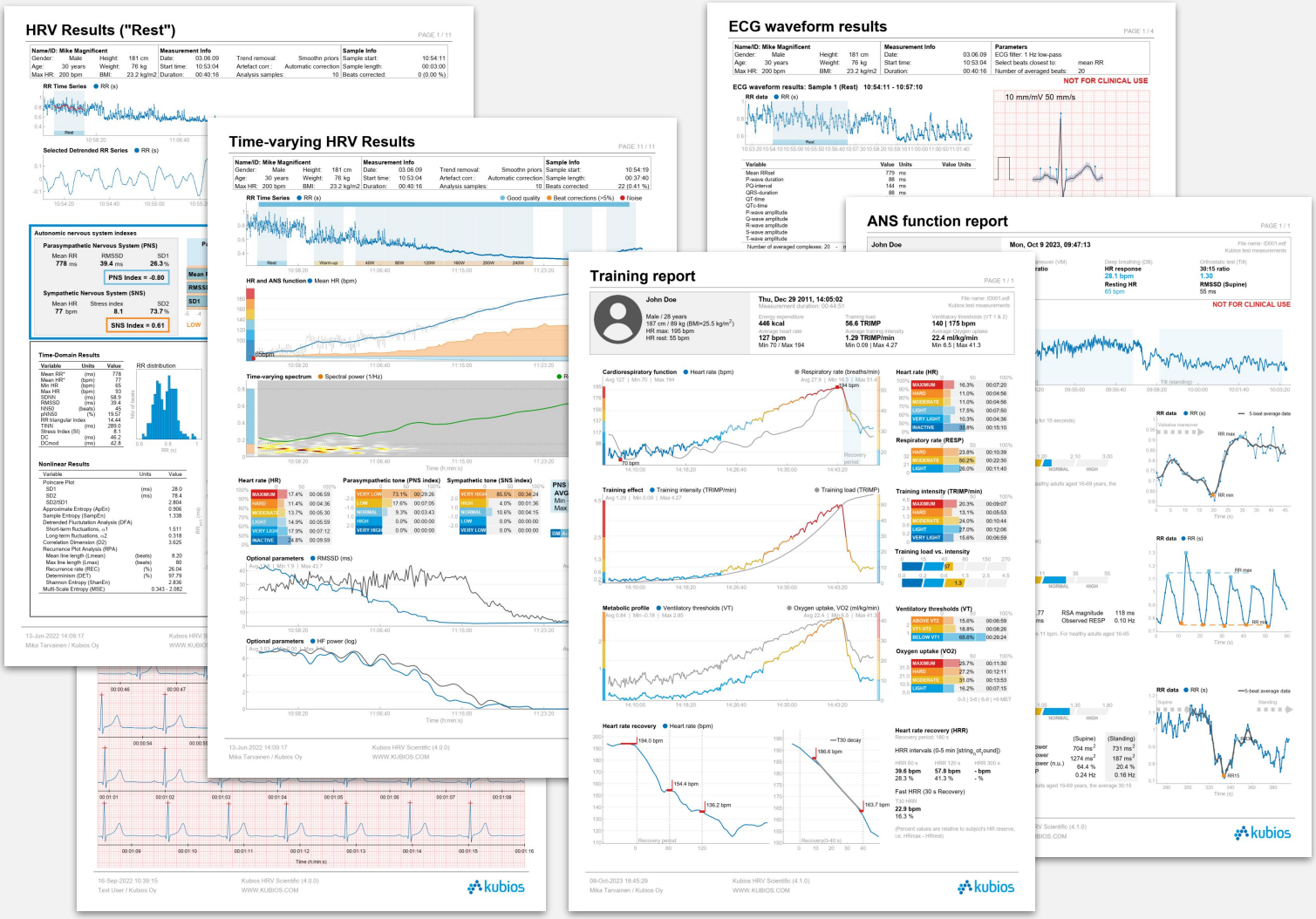
- PDF report with ECG waveform results and graphics every analysis sample (multi-page report, one page covering results for three samples)
- CSV and “SPSS friendly” exports. ECG waveform analysis results are included in these exports (alongside the HRV analysis results) if ECG waveform analysis is switched on

ANS function analysis

- PDF report with Valsalva maneuver, deep breathing, and head-up tilt analysis results and graphs
- CSV export with numeric analysis values

Training data analysis

- PDF report with training intensity and heart rate recovery analysis results and graphs
- CSV export with numeric analysis values



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