

Reporting Summary

Nature Research wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Research policies, see [Authors & Referees](#) and the [Editorial Policy Checklist](#).

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a Confirmed

- ☐ ☒ The exact sample size (n) for each experimental group/condition, given as a discrete number and unit of measurement
- ☐ ☒ A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
- ☒ ☐ The statistical test(s) used AND whether they are one- or two-sided
Only common tests should be described solely by name; describe more complex techniques in the Methods section.
- ☒ ☐ A description of all covariates tested
- ☒ ☐ A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
- ☐ ☒ A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
- ☒ ☐ For null hypothesis testing, the test statistic (e.g. F , t , r) with confidence intervals, effect sizes, degrees of freedom and P value noted
Give P values as exact values whenever suitable.
- ☒ ☐ For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
- ☒ ☐ For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
- ☐ ☒ Estimates of effect sizes (e.g. Cohen's d , Pearson's r), indicating how they were calculated

Our web collection on [statistics for biologists](#) contains articles on many of the points above.

Software and code

Policy information about [availability of computer code](#)

Data collection

Mbed was used to program microcontroller. CH Instrument was used for off-body sensor data collection. Comsol was used for simulations.

Data analysis

Origin 2018 was used to analyze all data, plot the data and calculate the statistical parameters. FFT analysis of the respiration sensor data using the built-in code in MATLAB R2018b

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors/reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Research [guidelines for submitting code & software](#) for further information.

Data

Policy information about [availability of data](#)

All manuscripts must include a [data availability statement](#). This statement should provide the following information, where applicable:

- Accession codes, unique identifiers, or web links for publicly available datasets
- A list of figures that have associated raw data
- A description of any restrictions on data availability

The data that support the plots within this paper and other findings of this study are available from the corresponding author upon request.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

- ☒ Life sciences ☐ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

Life sciences study design

All studies must disclose on these points even when the disclosure is negative.

Sample size	10 subjects (five trained and five untrained) were involved for on-body system validation; 1 subject for tyrosine supplement study; 15 subjects were involved in the purine study. Sample sizes were chosen on the basis of literature standards for proof-of-concept experiments. There is no self-selection biases or other biases.
Data exclusions	No data exclusion.
Replication	All attempts at replication were successful when following the device fabrication process described in the paper.
Randomization	The device was fabricated with same process and was tested in all participants under same conditions. Randomization was therefore not relevant to the study.
Blinding	Not relevant, because a blinding process wouldn't influence the sampling result

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

Methods

n/a	Involved in the study	n/a	Involved in the study
☒	☐ Antibodies	☒	☐ ChIP-seq
☒	☐ Eukaryotic cell lines	☒	☐ Flow cytometry
☒	☐ Palaeontology	☒	☐ MRI-based neuroimaging
☒	☐ Animals and other organisms		
☐	☒ Human research participants		
☒	☐ Clinical data		

Human research participants

Policy information about [studies involving human research participants](#)

Population characteristics	For on-body system validation, physically trained and untrained subjects (age range 18-65, male) were recruited. The trained subjects (athletes from Caltech sport teams) exercised regularly for at least 9 h per week while the untrained subjects had an average of 1 h of exercise per week. For purine study, six male patients with gout, four male subjects with hyperuricemia, and five healthy subjects (four male and one female) were recruited (age range 18-65).
Recruitment	The participating subjects (trained and untrained subjects, healthy and hyperuricemic subjects, gout patients), were recruited from Caltech campus, UCLA hospital and the neighboring communities through advertisement by posted notices, word of mouth, and email distribution. There were no self-selection biases or other biases.
Ethics oversight	California Institute of Technology

Note that full information on the approval of the study protocol must also be provided in the manuscript.