# Epinephrine/Norepinephrine ELISA Kit

Catalog Number KA1877

96 assays each

Version: 17

Intended for research use only

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# Introduction

## Intended Use

Enzyme Immunoassay for the quantitative determination of adrenaline (epinephrine) and noradrenaline (norepinephrine) in plasma and urine.

## Background

In humans the catecholamines adrenaline (epinephrine), noradrenaline (norepinephrine) and dopamine are neurotransmitters of the sympathetic nervous system and are involved in many physiological processes. The sympathetic nervous system sets the body to a heightened state of alert, also called as the body's fight-or-flight response.
In the human body the catecholamines and their metabolites indicate the adaption of the body to acute and chronic stress.

## Principle of the Assay

Adrenaline (epinephrine) and noradrenaline (norepinephrine) are extracted by using a cis-diol-specific affinity gel, acylated and then converted enzymatically.
The competitive ELISA kit uses the microtiter plate format. The antigen is bound to the solid phase of the microtiter plate. The derivatized standards, controls and samples and the solid phase bound analytes compete for a fixed number of antibody binding sites. After the system is in equilibrium, free antigen and free antigen-antibody complexes are removed by washing. The antibody bound to the solid phase is detected by an anti-rabbit IgG-peroxidase conjugate using TMB as a substrate. The reaction is monitored at 450 nm.
Quantification of unknown samples is achieved by comparing their absorbance with a standard curve prepared with known standard concentrations.

## General Information

### Materials Supplied

List of component

| Component | Amount |
|---|---|
| Adhesive Foil: Ready to use. Adhesive foils in a resealable pouch. | 4 slides x 2 |
| Wash Buffer Concentrate: 50x concentrated buffer with a non-ionic detergent and physiological pH. | 20 mL x 2 |
| Enzyme Conjugate: Ready to use, goat anti-rabbit immunoglobulins, conjugated with peroxidase.<br>  <br>H317 May cause an allergic skin reaction.<br>P280 Wear protective gloves.<br>P302+P352 IF ON SKIN: Wash with plenty of water.<br>P333+P313 If skin irritation or rash occurs: Get medical advice/attention.<br>P501 Dispose of contents/container to an authorised waste collection point. | 12 mL x 2 |
| Substrate: Ready to use, Chromogenic substrate containing 3,3',5,5'-tetramethylbenzidine, substrate buffer and hydrogen peroxide. | 12 mL x 2 |
| Stop Solution: Ready to use, 0.25 M sulfuric acid. | 12 mL x 2 |
| Adrenaline Microtiter Strips: Ready to use, antigen precoated microwell plate in a resealable blue pouch with desiccant. | 96 (8x12) wells |
| Noradrenaline Microtiter Strips: Ready to use, antigen precoated microwell plate in a resealable yellow pouch with desiccant. | 96 (8x12) wells |
| Adrenaline Antiserum: Ready to use. Rabbit anti-adrenaline antibody in buffer with proteins and non-mercury preservative, blue coloured.<br>Species of antibody is rabbit, species of protein in buffer is bovine. | 6 mL |
| Noradrenaline Antiserum: Ready to use. Rabbit anti-noradrenaline antibody in buffer with proteins and non-mercury preservative, yellow coloured.<br>Species of antibody is rabbit, species of protein in buffer is bovine. | 6 mL |
| Adjustment Buffer: Ready to use, TRIS buffer. | 4 mL |
| Acylation Buffer: Ready to use. Buffer with light alkaline pH for the acylation. | 20 mL |
| Acylation Reagent: Ready to use. Acylation reagent in DMSO. | 3 mL |
| Assay Buffer: Ready to use, 1 M hydrochloric acid and a non-mercury preservative.<br>  <br>H314 Causes severe skin burns and eye damage.<br>P280 Wear protective gloves, protective clothing, eye protection.<br>P303+P361+P353 IF ON SKIN (or hair): Take off immediately all contaminated clothing. Rinse skin with water. | 6 mL |

| | |
|---|---|
| P305+P351+P338 IF IN EYES: Rinse cautiously with water for several minutes. Remove contact lenses, if present and easy to do. Continue rinsing.<br>P310 Immediately call a doctor, a POISON CENTER.<br>P501 Dispose of contents/container to an authorized waste collection point. | |
| Coenzyme: Ready to use, S-adenosyl-L-methionine. | 4 mL |
| Enzyme: Lyophilized Catechol-O-methyltransferase. Catechol-O-methyltransferase from pig liver. | 4 vials |
| Extraction Buffer: Ready to use, buffer containing carbonate. | 6 mL |
| Extraction Plate: Ready to use, coated with boronate affinity gel in a resealabel pouch. | 48 wells x 2 |
| Hydrochloric Acid: Ready to use, 0.025 M hydrochloric acid, yellow coloured. | 20 mL |

Standards and Controls - Ready to use

| Component | Concentration (ng/mL) | | Concentration (nmol/L) | | Amount |
|---|---|---|---|---|---|
| | Adrenaline | Noradrenaline | Adrenaline | Noradrenaline | |
| Standard A | 0 | 0 | 0 | 0 | 4 mL |
| Standard B | 1 | 5 | 5.5 | 30 | 4 mL |
| Standard C | 4 | 20 | 22 | 118 | 4 mL |
| Standard D | 15 | 75 | 82 | 443 | 4 mL |
| Standard E | 50 | 250 | 273 | 1478 | 4 mL |
| Standard F | 200 | 1000 | 1092 | 5910 | 4 mL |
| Control 1 | Refer to QC report for expected value and acceptable range. | | | | 4 mL |
| Control 2 | Refer to QC report for expected value and acceptable range. | | | | 4 mL |

Conversion: Adrenaline (ng/mL) x 5.46 = Adrenaline (nmol/L)

Noradrenaline (ng/mL) x 5.91 = Noradrenaline (nmol/L)

Content: Acidic buffer with non-mercury stabilizer, spiked with defined quantity of adrenaline and noradrenaline

## Storage Instruction

Store the unopened reagents at 2-8°C until expiration date. Do not use components beyond the expiry date indicated on the kit labels. Once opened the reagents are stable for 2 months when stored at 2-8°C. Once the resealable pouch has been opened, care should be taken to close it tightly with desiccant again.

## Materials Required but Not Supplied

- ✓ Calibrated precision pipettes to dispense volumes between 10-700 µL; 1 mL.
- ✓ Microtiter plate washing device (manual, semi-automated or automated).
- ✓ ELISA reader capable of reading absorbance at 450 nm and if possible 620 - 650 nm.
- ✓ Microtiter plate shaker (shaking amplitude 3 mm; approx. 600 rpm).
- ✓ Absorbent material (paper towel).

- ✓ Water (deionized, distilled, or ultra-pure).
- ✓ Vortex mixer

## Precautions for Use

- Procedural cautions, guidelines and warnings

1. This kit is intended for professional use only. Users should have a thorough understanding of this protocol for the successful use of this kit. Only the test instruction provided with the kit is valid and has to be used to run the assay. Reliable performance will only be attained by strict and careful adherence to the instructions provided.
2. The principles of Good Laboratory Practice (GLP) have to be followed.
3. In order to reduce exposure to potentially harmful substances, wear lab coats, disposable protective gloves and protective glasses where necessary.
4. All kit reagents and specimens should be brought to room temperature and mixed gently but thoroughly before use. For dilution or reconstitution purposes, use deionized, distilled, or ultra-pure water. Avoid repeated freezing and thawing of reagents and specimens.
5. The microplate contains snap-off strips. Unused wells must be stored at 2°C to 8°C in the sealed foil pouch with desiccant and used in the frame provided. Microtiter strips which are removed from the frame for usage should be marked according to avoid any mix-up.
6. Standards, Controls and specimen samples should be assayed in duplicate.
7. Once the test has been started, all steps should be completed without interruption. Make sure that the required reagents, materials and devices are prepared ready at the appropriate time.
8. Incubation times do influence the results. All wells should be handled in the same order and time intervals.
9. To avoid cross-contamination of reagents, use new disposable pipette tips for dispensing each reagent, sample, standard and control.
10. A standard curve must be established for each run.
11. The controls should be included in each run and fall within established confidence limits. The confidence limits are listed in the QC-Report provided with the kit.
12. Do not mix kit components with different lot numbers within a test and do not use reagents beyond expiry date as shown on the kit labels.
13. For information on hazardous substances included in the kit please refer to Material Safety Data Sheet (MSDS). The Material Safety Data Sheet for this product is made available directly on the website of the manufacturer or upon request.
14. Kit reagents must be regarded as hazardous waste and disposed according to national regulations.
15. In case of any severe damage to the test kit or components, the manufacturer has to be informed in writing, at the latest, one week after receiving the kit. Severely damaged single components must not be used for a test run. They must be stored properly until the manufacturer decides what to do with them. If it is decided that they are no longer suitable for measurements, they must be disposed of in accordance with national regulations.

- Limitations

  Any inappropriate handling of samples or modification of this test might influence the results.

- Interfering substance

✓ Plasma: Samples containing precipitates or fibrin strands or which are haemolytic or lipemic might cause inaccurate results. Hemolytic samples (up to 4 mg/mL hemoglobin), icteric samples (up to 50 mg/dL bilirubin) and lipemic samples (up to 800 mg/dL triglycerides) have no influence on the assay results. If the concentrations cannot be estimated and there are doubts as to whether the above limit values for hemolytic, icteric or lipemic samples are complied with, the samples should not be used in the assay.

✓ 24-hour urine: please note the sample preparation! If the percentage of the final concentration of acid is too high, this will lead to incorrect results for the urine samples.

- Drug interferences

  There are no known substances which ingestion interferes with the measurement of catecholamine level in the sample.

- High-Dose-Hook effect

  No hook effect was observed in this test.

## Assay Protocol

### Reagent Preparation

- Wash Buffer
  Dilute the 20 mL Wash Buffer Concentrate with water (deionized, distilled, or ultra-pure) to a final volume of 1000 mL.
  Storage: 2 months 2-8°C
- Enzyme Solution
  Reconstitute the content of the vial labelled 'Enzyme' with 1 mL water (deionized, distilled, or ultra-pure) and mix thoroughly. Add 0.3 mL of Coenzyme followed by 0.7 mL of Adjustment Buffer. The total volume of the Enzyme Solution is 2.0 mL.
  *Note: The Enzyme Solution has to be prepared freshly prior to the assay (not longer than 10-15 minutes in advance). Discard after use!*
- Adrenaline Microtiter Strips and Noradrenaline Microtiter Strips
  In rare cases residues of the blocking and stabilizing reagent can be seen in the wells as small, white dots or lines. These residues do not influence the quality of the product.
- Acylation Reagent
  The Acylation Reagent has a freezing point of 18.5 °C. To ensure that the Acylation Reagent is liquid when being used, it must be ensured that the Acylation Reagent has reached room temperature and forms a homogeneous, crystal-free solution before being used.

### Sample Preparation

- Plasma
  Whole blood should be collected into centrifuge tubes containing EDTA as anti-coagulant and centrifuged according to manufacturer's instructions immediately after collection.
  In case of hemolytic, icteric or lipemic samples see Interfering substance section.
  Storage: up to 6 hours at 2-8°C; for longer period (up to 6 months) at -20°C.
  Repeated freezing and thawing should be avoided.
- Urine
  Spontaneous urine or 24-hours urine, collected in a bottle containing 10-15 mL of 6 M HCl, can be used. If 24-hour urine is used please record the total volume of the collected urine.
  Storage: up to 48 hours at 2-8°C, up to 24 hours at room temperature, for longer periods (up to 6 months) at -20°C. Repeated freezing and thawing should be avoided. Avoid exposure to direct sunlight.

## Assay Procedure

Allow all reagents and samples to reach room temperature and mix thoroughly by gentle inversion before use. Number the Extraction Plate and microwell plates (Microtiter Strips which are removed from the frame for usage should be marked accordingly to avoid any mix-up). Duplicate determinations are recommended.
The binding of the antisera and of the enzyme conjugate and the activity of the enzyme are temperature dependent. The higher the temperature, the higher the absorption values will be. Varying incubation times will have similar influences on the absorbance. The optimal temperature during the enzyme immunoassay is between 20 – 25 °C.
*Note: The use of a microtiter plate shaker with the following specifications is mandatory: shaking amplitude 3 mm; approx. 600 rpm. Shaking with differing settings might influence the results.*
*In case of overflow, read the absorbance of the solution in the wells within 10 minutes, using a microplate reader set to 405 nm.*

- Sample preparation, extraction and acylation

1. Pipette 10 µL of standards, controls, urine samples and 300 µL of plasma samples into the respective wells of the Extraction Plate.
2. Add 250 µL of water (deionized, distilled, or ultra-pure) to the wells with standards, controls and urine samples.
3. Pipette 50 µL of Assay Buffer into all wells
4. Pipette 50 µL of Extraction Buffer into all wells
5. Cover plate with adhesive foil and incubate 30 min at RT (20-25°C) on a shaker (approx. 600 rpm).
6. Remove the foil. Empty plate and blot dry by tapping the inverted plate on absorbent material.
7. Pipette 1 mL of Wash Buffer into all wells. Incubate the plate for 5 min at RT (20-25°C) on a shaker (approx. 600 rpm). Empty plate and blot dry by tapping the inverted plate on absorbent material.
8. Pipette another 1 mL of Wash Buffer into all wells. Incubate the plate for 5 min at RT (20-25°C) on a shaker (approx. 600 rpm). Empty plate and blot dry by tapping the inverted plate on absorbent material.
9. Pipette 150 µL of Acylation Buffer into all wells.
10. Pipette 25 µL of Acylation Reagent into all wells.
11. Incubate 15 min at RT (20-25°C) on a shaker (approx. 600 rpm).
12. Empty plate and blot dry by tapping the inverted plate on absorbent material.
13. Pipette 1 mL of Wash Buffer into all wells. Incubate the plate for 10 min at RT (20-25°C) on a shaker (approx. 600 rpm). Empty plate and blot dry by tapping the inverted plate on absorbent material.
14. Pipette 150 µL of Hydrochloric Acid into all wells.
15. Cover plate with adhesive foil. Incubate 10 min at RT (20-25°C) on a shaker (approx. 600 rpm). Remove the foil and discard. *Note: Do not decant the supernatant thereafter!*
    The following volumes of the supernatant are needed for the subsequent ELISA:
    Adrenaline 100 µL  Noradrenaline 20 µL.

- Adrenaline ELISA

1. Pipette 25 µL of the Enzyme Solution (refer to Reagent Preparation) into all wells of the Adrenaline Microtiter Strips.
2. Pipette 100 µL of the extracted standards, controls and samples into the appropriate wells.
3. Incubate for 30 min at RT (20-25°C) on a shaker (approx. 600 rpm).
4. Pipette 50 µL of the respective Adrenaline Antiserum into all wells and cover plate with Adhesive Foil.
5. Incubate for 2 h at RT (20-25°C) on a shaker (approx. 600 rpm).
6. Remove the foil. Discard or aspirate the content of the wells. Wash the plate 3 x by adding 300 µL of Wash Buffer, discarding the content and blotting dry each time by tapping the inverted plate on absorbent material.
7. Pipette 100 µL of the Enzyme Conjugate into all wells.
8. Incubate for 30 min at RT (20-25°C) on a shaker (approx. 600 rpm).
9. Discard or aspirate the content of the wells. Wash the plate 3 x by adding 300 µL of Wash Buffer, discarding the content and blotting dry each time by tapping the inverted plate on absorbent material.
10. Pipette 100 µL of the Substrate into all wells and incubate for 25 ± 5 min at RT (20-25°C) on a shaker (approx. 600 rpm). *Note: Avoid exposure to direct sunlight!*
11. Add 100 µL of the Stop Solution to each well and shake the microtiter plate to ensure a homogeneous distribution of the solution.
12. Read the absorbance of the solution in the wells within 10 minutes, using a microplate reader set to 450 nm (if available a reference wavelength between 620 nm and 650 nm is recommended).

- Noradrenaline ELISA

1. Pipette 25 µL of the Enzyme Solution (refer to Reagent Preparation) into all wells of the Noradrenaline Microtiter Strips.
2. Pipette 20 µL of the extracted standards, controls and samples into the appropriate wells.
3. Incubate for 30 min at RT (20-25°C) on a shaker (approx. 600 rpm).
4. Pipette 50 µL of the Noradrenaline Antiserum into all wells and cover plate with Adhesive Foil.
5. Incubate for 2 h at RT (20-25°C) on a shaker (approx. 600 rpm).
6. Remove the foil. Discard or aspirate the content of the wells. Wash the plate 3 x by adding 300 µL of Wash Buffer, discarding the content and blotting dry each time by tapping the inverted plate on absorbent material.
7. Pipette 100 µL of the Enzyme Conjugate into all wells.
8. Incubate for 30 min at RT (20-25°C) on a shaker (approx. 600 rpm).
9. Discard or aspirate the content of the wells. Wash the plate 3 x by adding 300 µL of Wash Buffer, discarding the content and blotting dry each time by tapping the inverted plate on absorbent material.
10. Pipette 100 µL of the Substrate into all wells and incubate for 25 ± 5 min at RT (20-25°C) on a shaker (approx. 600 rpm). *Note: Avoid exposure to direct sun light!*
11. Add 100 µL of the Stop Solution to each well and shake the microtiter plate to ensure a homogeneous distribution of the solution.
12. Read the absorbance of the solution in the wells within 10 minutes, using a microplate reader set to 450 nm (if available a reference wavelength between 620 nm and 650 nm is recommended).

## Data Analysis

### Calculation of Results

| | | Adrenaline | Noradrenaline |
|---|---|---|---|
| Measuring range | Urine | 0.7 - 200 ng/mL | 2.5 – 1000 ng/mL |
| | Plasma | 18 - 6667 pg/mL | 93 - 33333 pg/mL |

- The standard curves are obtained by plotting the absorbance readings (calculate the mean absorbance) of the standards (linear, y-axis) against the corresponding standard concentrations (logarithmic, x-axis).
- Use a non-linear regression for curve fitting (e.g. spline, 4-parameter, akima).
  *Note: This assay is a competitive assay. This means: the OD-values are decreasing with increasing concentrations of the analyte. OD-values found below the standard curve correspond to high concentrations of the analyte in the sample and have to be reported as being positive.*

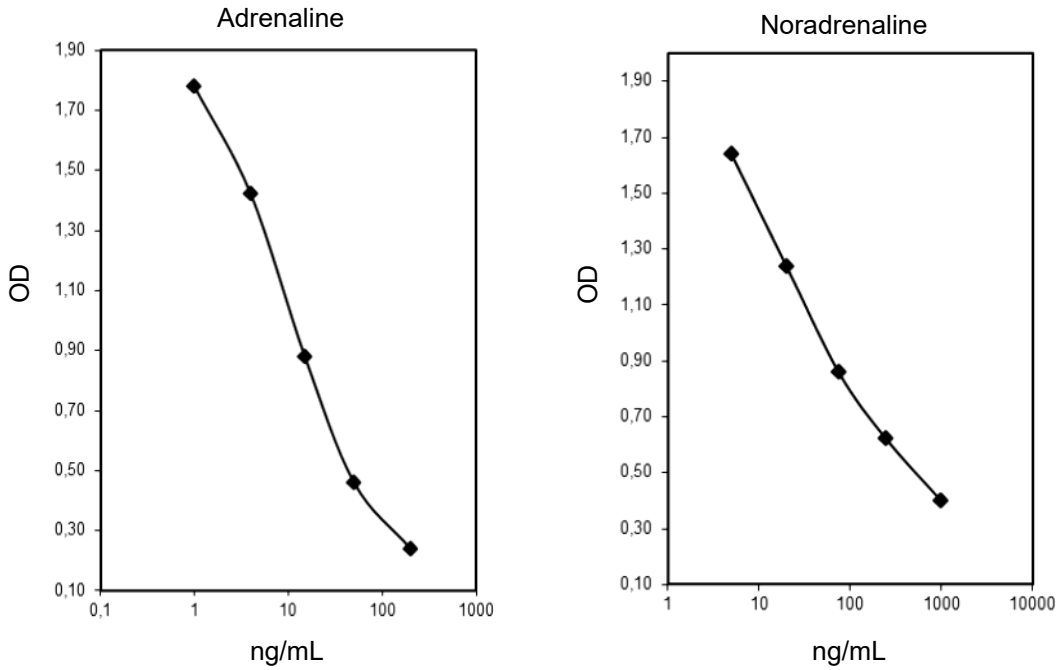
- Urine samples and controls
  The concentrations of the urine samples and the Controls can be read directly from the standard curve. Calculate the 24h excretion for each urine sample: $\mu g/24h = \mu g/L \times L/24h$

- Plasma samples
  The read concentrations of the plasma samples have to be divided by 30.

- Conversion
  Adrenaline (ng/mL) x 5.46 = Adrenaline (nmol/L)
  Noradrenaline (ng/mL) x 5.91 = Noradrenaline (nmol/L)

- Quality control
  The confidence limits of the kit controls are printed on the QC-Report.

- Typical standard curves: Example, do not use for calculation.




**Performance Characteristics**

- Analytical Sensitivity

| | | Adrenaline | Noradrenaline |
|---|---|---|---|
| LOB | Urine (ng/mL) | 0.8 | 1.5 |
| | Plasma (pg/mL) | 9.3 | 32 |
| LOD | Urine (ng/mL) | 0.9 | 1.7 |
| | Plasma (pg/mL) | 10 | 36 |
| LOQ | Urine (ng/mL) | 0.7 | 2.5 |
| | Plasma (pg/mL) | 18 | 93 |

- Analytical Specificity (Cross Reactivity)

| Substance | Cross Reactivity (%) | |
|---|---|---|
| | Adrenaline | Noradrenaline |
| Derivatized Adrenaline | 100 | 0.08 |
| Derivatized Noradrenaline | 0.13 | 100 |
| Derivatized Dopamine | < 0.01 | 0.03 |
| Metanephrine | 0.18 | < 0.01 |
| Normetanephrine | < 0.01 | 0.16 |
| 3-Methoxytyramine | < 0.01 | < 0.01 |
| 3-Methoxy-4-hydroxyphenylglycol | < 0.01 | < 0.01 |
| Tyramine | < 0.01 | < 0.01 |

| | | |
|---|---|---|
| Phenylalanine, Caffeinic acid, L-Dopa, Homovanillic acid, Tyrosine, 3-Methoxy-4-hydroxymandelic acid | < 0.01 | < 0.01 |

- Precision

| Intra-Assay Urine (n=60) | | | | Intra-Assay Plasma (n=60) | | | |
|---|---|---|---|---|---|---|---|
| | Sample | Range (ng/mL) | CV (%) | | Sample | Range (pg/mL) | CV (%) |
| Adrenaline | 1 | 6.2 ± 1.1 | 17.4 | Adrenaline | 1 | 64.7 ± 15.9 | 24.7 |
| | 2 | 21.4 ± 2.7 | 12.4 | | 2 | 258 ± 32.5 | 12.7 |
| | 3 | 59.4 ± 7.8 | 13.1 | | 3 | 948 ± 105 | 11.0 |
| Noradrenaline | 1 | 26.1 ± 3.6 | 13.8 | Noradrenaline | 1 | 510 ± 65 | 12.8 |
| | 2 | 97 ± 12.8 | 13.4 | | 2 | 1358 ± 194 | 14.3 |
| | 3 | 267 ± 35 | 13.1 | | 3 | 3363 ± 374 | 11.1 |
| Inter-Assay Urine (n=33) | | | | Inter-Assay Plasma (n=18) | | | |
| | Sample | Range (ng/mL) | CV (%) | | Sample | Range (pg/mL) | CV (%) |
| Adrenaline | 1 | 5.2 ± 0.9 | 17.9 | Adrenaline | 1 | 76.4 ± 11.1 | 14.5 |
| | 2 | 17.8 ± 2.1 | 11.7 | | 2 | 247 ± 27.5 | 11.1 |
| | 3 | 54.2 ± 6.6 | 12.1 | | 3 | 771 ± 101 | 13.1 |
| Noradrenaline | 1 | 19.5 ± 3.9 | 20.0 | Noradrenaline | 1 | 445 ± 40.9 | 9.2 |
| | 2 | 80.6 ± 10.6 | 13.2 | | 2 | 1232 ± 134 | 10.9 |
| | 2 | 226 ± 39.5 | 17.4 | | 2 | 3283 ± 302 | 9.2 |

- Lot-to-Lot

| | | | | |
|---|---|---|---|---|
| Adrenaline | Urine | Sample | Mean ± SD [ng/ml] | CV (%) |
| | | 1 | 6.6 ± 0.9 | 13.7 |
| | | 2 | 23.5 ± 1.5 | 6.2 |
| | Plasma | Sample | Mean ± SD [pg/ml] | CV (%) |
| | | 1 | 202 ± 26.7 | 11.8 |
| Noradrenaline | Urine | Sample | Mean ± SD [ng/ml] | CV (%) |
| | | 1 | 124 ± 13.2 | 10.7 |
| | | 2 | 29.3 ± 3.7 | 12.6 |
| | Plasma | Sample | Mean ± SD [pg/ml] | CV (%) |
| | | 1 | 1,071 ± 97.3 | 5.3 |

- Linearity

| | | Serial dilution up to | Range (%) | Mean (%) |
|---|---|---|---|---|
| Adrenaline | Urine | 1:512 | 92 – 123 | 108 |
| | Plasma | 1:512 | 94 – 115 | 105 |
| Noradrenaline | Urine | 1:512 | 100 – 127 | 112 |
| | Plasma | 1:512 | 102 – 125 | 112 |

- Recovery

  Recovery was determined according to the CLSI standard EP 34 1st ed.

| | | Mean (%) | Range (%) | Range |
|---|---|---|---|---|
| Adrenaline | Urine | 95 | 89-98 | 0.27-61 ng/mL |
| | Plasma | 105 | 88-117 | 9.1-4268 pg/mL |
| Noradrenaline | Urine | 96 | 70-118 | 1.8-249 ng/mL |
| | Plasma | 87 | 75-107 | 51-14251 pg/mL |

✓ Metrological Traceability

The values assigned to the standards and controls of the Epinephrine/Norepinephrine ELISA Kit are traceable to SI Units by weighing with quality-controlled analyte.

| Standards and Controls | |
|---|---|
| | Uncertainty [%] |
| Adrenaline | 3.5 |
| Noradrenaline | 4.1 |

| | | Concentration | Expanded Uncertainty [%] k = 2* |
|---|---|---|---|
| Adrenaline | Urine | 5.2 ng/mL | 36.5 |
| | | 17.8 ng/mL | 24.4 |
| | | 54.2 ng/mL | 25.2 |
| | Plasma | 76.4 pg/mL | 29.8 |
| Noradrenaline | Urine | 19.5 ng/mL | 408 |
| | | 80.6 ng/mL | 24.6 |
| | | 226 ng/mL | 35.7 |
| | Plasma | 445 pg/mL | 20.1 |

## Resources

### References


1. Kim *et al.* Vitamin C prevents stress-induced damage on the heart caused by the death of cardiomyocytes, through the down-regulation of the excessive production of catecholamine, TNF-α, and ROS production in GULO(-I-) Vit C-Insufficient mice. Free Radical Biology and Medicine, 65:573-583 (2013).
2. Bada *et al.* Peripheral vasodilatation determines cardiac output in exercising humans: insight from atrial pacing. The Journal of Physiology, 590(8):2051-2060 (2012).
3. Parks *et al.* Employment and work schedule are related to telomere length in women. Occupational & Environmental Medicine 68(8):582-589 (2011).
4. Eisenhofer, G., C. Pamporaki, and J.W.M. Lenders, Biochemical Assessment of Pheochromocytoma and Paraganglioma. Endocr Rev, 2023. 44(5): p. 862-909.

**Plate Layout**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 12 | | | | | | | | |
| 11 | | | | | | | | |
| 10 | | | | | | | | |
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| 3 | | | | | | | | |
| 2 | | | | | | | | |
| 1 | | | | | | | | |
| | A | B | C | D | E | F | G | H |