**High Sensitivity**

# SALIVARY CORTISOL

## ENZYME IMMUNOASSAY KIT

For Diagnostic In-Vitro Use

$C\epsilon$

Item No. 1-3102, (Single) 96-Well Kit;

1-3102-5, (5-Pack) 480 Wells

Rev. 10-09

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# HS SALIVARY CORTISOL EIA KIT

## Intended Use

The Salimetrics™ cortisol kit is a competitive immunoassay specifically designed and validated for the quantitative *in vitro* diagnostic measurement of salivary cortisol. This kit may be used to measure adrenal cortical function and as a screen for Cushing's and Addison's disease. (1,2)  Saliva cortisol accurately reflects the amount of serum cortisol in the circulation.  Salimetrics has not validated this kit for use with serum or plasma samples.

***Please read the complete kit insert before performing this assay.  Failure to follow kit procedure and recommendations for saliva collection and sample handling may result in false values.***

For further information about this kit, its application, or the procedures in this insert, please contact the technical service team at Salimetrics or your local sales representative.

## Introduction

Cortisol (hydrocortisone, Compound F) is the major glucocorticoid produced in the adrenal cortex. Cortisol is actively involved in the regulation of calcium absorption, blood pressure maintenance, anti-inflammatory function, gluconeogenesis, gastric acid and pepsin secretion, and immune function. (3,4,5)

Cortisol production has a circadian rhythm. (6)  Levels peak in the early morning and drop to the lowest concentration at night. (7)  Levels rise independently of circadian rhythm in response to stress. (8)  Increased cortisol production is associated with Cushing's syndrome and adrenal tumors, while decreased cortisol production is associated with adrenal insufficiency (e.g., Addison's disease) and adrenocorticotropic hormone (ACTH) deficiency. (9)

In the blood only 1 to 15% of cortisol is in its unbound or biologically active form. The remaining cortisol is bound to serum proteins. (10)  Unbound serum cortisol enters the saliva via intracellular mechanisms, and in saliva the majority of cortisol

remains unbound to protein. (11)  Salivary cortisol levels are unaffected by salivary flow rate or salivary enzymes. (12)  Studies consistently report high correlations between serum and saliva cortisol, indicating that salivary cortisol levels reliably estimate serum cortisol levels. (13,14,15)

## Test Principle

A microtitre plate is coated with monoclonal antibodies to cortisol.  Cortisol in standards and unknowns competes with cortisol linked to horseradish peroxidase for the antibody binding sites.  After incubation, unbound components are washed away.  Bound cortisol peroxidase is measured by the reaction of the peroxidase enzyme on the substrate tetramethylbenzidine (TMB).  This reaction produces a blue color.  A yellow color is formed after stopping the reaction with sulfuric acid.  Optical density is read on a standard plate reader at 450 nm.  The amount of cortisol peroxidase detected, as measured by the intensity of color, is inversely proportional to the amount of cortisol present. (16)

## pH Indicator

A pH indicator in the assay diluent alerts the user to samples with high or low pH values.  Acidic samples will turn the diluent yellow.  Alkaline samples will turn the diluent purple.  Dark yellow or purple wells indicate that a pH value for that sample should be obtained using pH strips.  Cortisol values from samples with a pH $\leq 3.5$ or $\geq 9.0$ may be artificially inflated or lowered. (17)

## Storage

All components of this kit are stable at 2-8° C until the kit's expiration date.

## Safety Precautions

- Liquid stop is a 3-molar solution of sulfuric acid.  This solution is caustic; use with care.  Stop solution in powdered form is not sulfuric acid-based and is mildly corrosive.

- See "Material Safety Data" for additional information.

## Materials Supplied with Kit

| | Item | Quantity/Size |
|---|------|---------------|
| 1 | **Microtitre Plate**<br>Coated with monoclonal anti-cortisol antibodies. | 1/96-well |
| 2 | **Cortisol Standards**<br>Ready to use,  traceable to NIST standard:<br>3.0, 1.0, 0.333, 0.111, 0.037, 0.012 µg/dL<br>(82.77, 27.59, 9.19, 3.06, 1.02, 0.33 nmol/L).<br>Contain: cortisol, buffer, preservative. | 6 vials/500 µL each |
| 3 | **Cortisol Controls**<br>High, Low.  Ready to use, see vials for target values.<br>Contain: cortisol, buffer, preservative. | 2 vials/500 µL each |
| 4 | **Wash Buffer Concentrate (10x)**<br>Dilute before use according to Reagent Preparation.<br>Contains: phosphate buffer, detergent, preservative. | 1 bottle/100 mL |
| 5 | **Assay Diluent**<br>Contains: phosphate buffer, pH indicator, preservative. | 1 bottle/60 mL |
| 6 | **Cortisol Enzyme Conjugate**<br>Concentrate.  Dilute before use with assay diluent.<br>(See step 5 of Procedure.)  Contains: cortisol<br>conjugated to HRP, preservative. | 1 vial/50 µL |
| 7 | **TMB Substrate Solution**<br>Non-toxic, ready to use. | 1 bottle/25 mL |
| 8 | **3 M Stop Solution***<br>Contains: sulfuric acid. | 1 bottle/12.5 mL |
| 9 | **Non-Specific Binding (NSB) Wells**<br>Do not contain anti-cortisol antibody. | 1 strip |

*Stop solution is provided in powdered form to some customers outside the USA.
Reconstitute as directed in Reagent Preparation.

## Materials Needed But Not Supplied

- Precision pipette to deliver 15 and 25 µL

- Precision multichannel pipette to deliver 50 µL and 200 µL

- Vortex

- Plate rotator with 0.08-0.17 inch orbit (if unavailable, tap plate to mix)

- Plate reader with a 450 nm filter

- Log-linear graph paper or computer software for data reduction

- Deionized water

- Reagent reservoirs

- One disposable tube capable of holding 24 mL

- Pipette tips

- Serological pipette to deliver up to 24 mL

## Specimen Collection

Avoid sample collection within 60 minutes after eating a major meal or within 12 hours after consuming alcohol. Bovine hormones normally present in dairy products can cross-react with anti-cortisol antibodies and cause false results. Acidic or high sugar foods can compromise assay performance by lowering sample pH and influencing bacterial growth. To minimize these factors, rinse mouth thoroughly with water 10 minutes before sample is collected.

Donors may collect whole saliva by tilting the head forward, allowing the saliva to pool on the floor of the mouth, then passing the saliva through a short straw into a polypropylene vial. Adult samples and samples from children ages 6 and above may also be collected using the Salimetrics Oral Swab (SOS), Item No. 5001.02. Infant samples may be collected with the Sorbette, Item No. 5029.00, or cotton ropes, Item

No. 5016.00.  For accurate results Sorbettes and cotton collection materials should be completely saturated before removal.  Collection protocols are available on request.

Samples visibly contaminated with blood should be recollected.  Samples collected from populations that have little or no dental care, or known oral health problems, may be screened for possible blood contamination (18,19) using our Blood Contamination EIA Kit (Item No.1-1302;1-3102-5).  Do not use dipsticks, which result in false positive values due to salivary enzymes.

It is important to record the time and date of specimen collection when samples are obtained due to the diurnal variation in cortisol levels.  Samples for Cushing's diagnosis should be collected at 11:00 pm.

## Sample Handling and Preparation

After collection it is important to keep samples cold, in order to avoid bacterial growth in the specimen.  Refrigerate samples within 30 minutes, and freeze at or below -20° C within 4 hours after collection.  (Samples may be stored at -20° C or lower for long-term storage.)

***Do not add sodium azide to saliva samples as a preservative, as it may cause interference in the immunoassay.***

Freezing saliva samples will precipitate the mucins.  On day of assay, thaw completely, vortex, and centrifuge at 1500 x g (@3000 rpm) for 15 minutes.  Samples should be at room temperature before adding to assay plate.  Pipette clear sample into appropriate wells.  Be careful not to disrupt the pellet, since particulate matter may interfere with antibody binding, leading to falsely elevated results.

Avoid multiple freeze-thaw cycles.  However, if samples have been refrozen, centrifuge again prior to assaying.

## Reagent Preparation

- Bring all reagents to room temperature and mix before use. A minimum of 1.5 hours is necessary for the 24 mL of assay diluent used in Step 5 (conjugate dilution) to come to room temperature.

- Bring microtitre plate to room temperature before use. *It is important to keep the pouch with the plate strips closed until warmed to room temperature as humidity may have an effect on the coated wells.*

- Prepare 1X wash buffer by diluting wash buffer concentrate 10-fold with room-temperature deionized water (100 mL of 10X wash buffer to 900 mL of deionized $H_2O$). *Dilute only enough for current day's use, and discard any leftover reagent.* (If precipitate has formed in the concentrated wash buffer, it may be heated to 40° C for 15 minutes. Cool to room temperature before use in assay.)

- Reconstitute powdered stop solution (if appropriate) by adding 12.5 mL deionized water. Let sit for 10 minutes before use.

## Quality Control

The Salimetrics high and low salivary cortisol controls should be run with each assay. The control ranges established at Salimetrics are to be used as a guide. Each laboratory should establish its own range. Variations between laboratories may be caused by differences in techniques and instrumentation.

# General Kit Use Advice

- This kit uses break-apart microtitre strips. You may run less than a full plate. Unused wells must be stored at 2-8° C in the foil pouch with desiccant and used in the frame provided.

- The quantity of reagent provided with this kit is sufficient for three partial runs. The volumes of wash buffer and conjugate prepared for assays using less than a full plate should be scaled down accordingly, keeping the same dilution ratio.

- Do not mix components from different lots of kits.

- When using a multichannel pipette, reagents should be added to duplicate wells at the same time. Follow the same sequence when adding additional reagents so that incubation time with reagents is the same for all wells.

- To ensure highest quality assay results, pipetting of samples and reagents must be done as quickly as possible (without interruption) across the plate. Ideally, the process should be completed within 20 minutes or less.

- When running multiple plates, or multiple sets of strips, a standard curve must be run with each individual plate and/or set of strips.

- The temperature of the laboratory may affect assays. Salimetrics' kits have been validated at 68-74º F (20-23.3º C). Higher or lower temperatures will cause an increase or decrease in OD values, respectively. Salimetrics cannot guarantee test results outside of this temperature range.

- Avoid microbial contamination of opened reagents. Salimetrics recommends using opened reagents within one month. Store all reagents at 2-8° C.

- Routine calibration of pipettes is critical for the best possible assay performance.

## Procedure

**Step 1:** Determine your plate layout.  Here is a suggested layout.

|   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|----|----|----|
| A | 3.000 Std | 3.000 Std | Control High | Control High | | | | | | | | |
| B | 1.000 Std | 1.000 Std | Control Low | Control Low | | | | | | | | |
| C | 0.333 Std | 0.333 Std | Unknown 1 | Unknown 1 | | | | | | | | |
| D | 0.111 Std | 0.111 Std | Unknown 2 | Unknown 2 | | | | | | | | |
| E | 0.037 Std | 0.037 Std | Unknown 3 | Unknown 3 | | | | | | | | |
| F | 0.012 Std | 0.012 Std | Unknown 4 | Unknown 4 | | | | | | | | |
| G | Zero | Zero | Unknown 5 | Unknown 5 | | | | | | | | |
| H | NSB | NSB | Unknown 6 | Unknown 6 | | | | | | | | |

**Step 2:** Keep the desired number of strips in the strip holder and place the remaining strips back in the foil pouch.  If you choose to place non-specific binding wells in H-1, 2, remove strips 1 and 2 from the strip holder and break off the bottom wells.  Place the strips back into the strip holder leaving H-1, 2 blank.  Break off 2 NSB wells from the strip of NSBs included in the foil pouch.  Place in H-1, 2.  Alternatively, NSBs may be placed wherever you choose on the plate.  Reseal the foil pouch containing unused wells and desiccant.  Store at 2-8° C.

> *Caution:  Extra NSB wells should not be used for determination of standards, controls or unknowns.*

**Step 3:** Pipette 24 mL of assay diluent into a disposable tube. Set aside for Step 5.

**Step 4**:

- Pipette 25 µL of standards, controls, and unknowns into appropriate wells. Standards, controls, and unknowns should be assayed in duplicate.

- Pipette 25 µL of assay diluent into 2 wells to serve as the zero value.

- Pipette 25 µL of assay diluent into each NSB well.

> *Note: To ensure highest quality assay results, pipetting of samples and reagents must be done as quickly as possible (without interruption) across the plate. Ideally, the process should be completed within 20 minutes or less.*

**Step 5:** Make a 1:1600 dilution of the conjugate by adding 15 µL of the conjugate to the 24 mL of assay diluent prepared in Step 3. (Scale down proportionally if not using the entire plate.) Immediately mix the diluted conjugate solution and pipette 200 µL into each well using a multichannel pipette.

**Step 6:** Mix plate on rotator for 5 minutes at 500 rpm (or tap to mix) and incubate at room temperature for an additional 55 minutes.

**Step 7:** Wash the plate 4 times with 1X wash buffer. A plate washer is recommended. However, washing may be done by gently squirting wash buffer into each well with a squirt bottle, or by pipetting 300 µL of wash buffer into each well, and then discarding the liquid by inverting the plate over a sink. After each wash, the plate should be thoroughly blotted on paper towels before being turned upright. *If using a plate washer, blotting is still recommended after the last wash.*

**Step 8:** Add 200 µL of TMB solution to each well with a multichannel pipette.

**Step 9:** Mix on a plate rotator for 5 minutes at 500 rpm (or tap to mix) and incubate the plate in the dark at room temperature for an additional 25 minutes.

**Step 10**: Add 50 µL of stop solution with a multichannel pipette.

**Step 11**:

- Mix on a plate rotator for 3 minutes at 500 rpm (or tap to mix).

  *Caution: Spillage may occur if mixing speed exceeds 600 rpm.*

- Wipe off bottom of plate with a water-moistened, lint-free cloth and wipe dry.

- Read in a plate reader at 450 nm. Read plate within 10 minutes of adding stop solution. (For best results, a secondary filter correction at 490 to 630 nm is recommended.)

## Limitations

- Diagnosis of Cushing's syndrome should be confirmed by additional diagnostic tests for the disease, such as low-dose dexamethasone suppression testing.

- Cortisol levels are elevated during the later stages of pregnancy and in women on oral contraceptives or after long-term use of oral contraceptives. (15, 20)

- Some studies show developmental differences in cortisol as well as an association between cortisol and weight. (21)

- Elevated cortisol levels can be found in conditions of sepsis, infection, chronic liver disease, and renal failure. Low cortisol levels result from liver disease, pituitary hyposecretion, hypothyroidism, or steroid therapy.

- See "Specimen Collection" recommendations to insure proper collection of saliva specimens and to avoid interfering substances.

# Assay Summary

1. Bring all reagents to room temperature and mix before use.

2. Bring plate to room temperature and prepare for use with NSB wells.

3. Prepare tube with 24 mL of assay diluent for conjugate dilution, which will be made later.

4. Prepare 1X wash buffer (and reconstitute stop solution, if appropriate).

5. Pipette 25 µL of standards, controls, and unknowns into appropriate wells.

6. Pipette 25 µL of assay diluent into zero and NSB wells.

7. Make final 1:1600 dilution of conjugate (15 µL into 24 mL assay diluent), mix, and immediately pipette 200 µL into each well.

8. Mix plate for 5 minutes at 500 rpm. Incubate for an additional 55 minutes at room temperature.

9. Wash plate 4 times with 1X wash buffer. Blot.

10. Add 200 µL TMB solution to each well.

11. Mix plate for 5 minutes at 500 rpm. Incubate in dark at room temperature for 25 additional minutes.

12. Add 50 µL stop solution to each well. Mix for 3 minutes at 500 rpm.

13. Wipe plate bottom clean and read within 10 minutes of adding stop.

## Calculations

1. Compute the average optical density (OD) for the zero (Bo) and NSB wells.

2. Subtract the average OD for the NSB wells from the average OD of the zero, standards, controls, and unknowns.

3. Calculate the percent bound (B/Bo) for each standard, control, and unknown by dividing the average OD (B) by the average OD for the zero (Bo).

4. Determine the concentrations of the controls and unknowns by interpolation using software capable of logistics. We recommend using a 4-parameter sigmoid minus curve fit.

Samples with cortisol values greater than 3.0 µg/dL (82.77 nmol/L) should be diluted with assay diluent and rerun for accurate results. To obtain the final cortisol concentration, multiply the concentration of the diluted sample by the dilution factor.
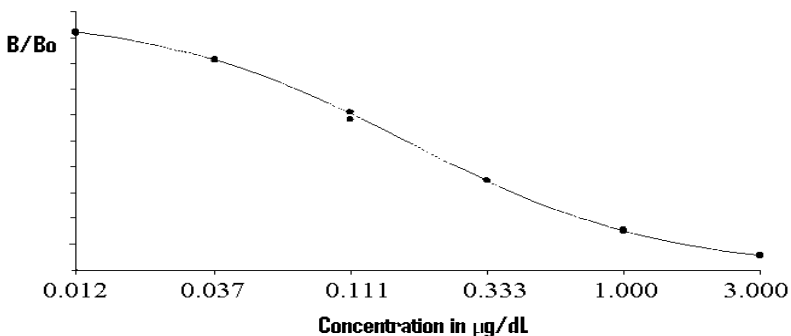
***When running multiple plates, or multiple sets of strips, a standard curve must be run with each individual plate and/or set of strips.***

## Typical Results

***The following chart and graph are for illustration only and should not be used to calculate results from another assay.***

| Well | Sample | Average OD | B | B/Bo | Cortisol (µg/dL) |
|------|--------|-----------|-----|------|------------------|
| A1,A2 | S1 | 0.094 | 0.071 | 0.048 | 3.000 |
| B1,B2 | S2 | 0.236 | 0.213 | 0.145 | 1.000 |
| C1,C2 | S3 | 0.524 | 0.501 | 0.340 | 0.333 |
| D1,D2 | S4 | 0.897 | 0.874 | 0.593 | 0.111 |
| E1,E2 | S5 | 1.219 | 1.196 | 0.812 | 0.037 |
| F1,F2 | S6 | 1.379 | 1.356 | 0.921 | 0.012 |
| G1,G2 | Bo | 1.496 | 1.473 | NA | NA |
| H1,H2 | NSB | 0.023 | NA | NA | NA |

**Example: HS Cortisol 4-Parameter Sigmoid Minus Curve Fit**



## Material Safety Data*

### *Hazardous Ingredients*

Liquid stop solution is caustic; use with care. *Note: Stop solution in powdered form is not sulfuric acid-based and is mildly corrosive.*

We recommend the procedures listed below for all kit reagents. Specific kit component MSDS sheets are available from Salimetrics upon request.

### *Handling*

Follow good laboratory procedures when handling kit reagents. Laboratory coats, gloves, and safety goggles are recommended. Wipe up spills using standard absorbent materials while wearing protective clothing. Follow local regulations for disposal.

### *Emergency Exposure Measures*

In case of contact, immediately wash skin or flush eyes with water for 15 minutes. Remove contaminated clothing. If inhaled, remove individual to fresh air. If individual experiences difficulty breathing, give oxygen and call a physician.

*The above information is believed to be accurate but is not all-inclusive. This information should be used only as a guide. Salimetrics will not be liable for accidents or damage resulting from contact with reagents.

# HS Salivary Cortisol EIA Kit Performance Characteristics

## *Correlation with Serum*

The correlation between serum and saliva cortisol was determined by assaying 49 matched samples using the Diagnostic Systems Laboratories serum Cortisol EIA and the Salimetrics HS Salivary Cortisol EIA.

The correlation between saliva and serum was highly significant, $\underline{r}\,(47) = 0.91,\ \underline{p} < 0.0001$.

## *Sensitivity*

The lower limit of sensitivity was determined by interpolating the mean minus 2 SDs for 10 sets of duplicates at 0 µg/dL standard. The minimal concentration of cortisol that can be distinguished from 0 is < 0.003 µg/dL.

## *Linearity of Dilution*

Two saliva samples were diluted with assay diluent and assayed.

| Sample | Dilution Factor | Expected (µg/dL) | Observed (µg/dL) | Recovery (%) |
|---|---|---|---|---|
| 1 | | | 2.176 | |
| | 1:2 | 1.088 | 1.065 | 97.9 |
| | 1:4 | 0.544 | 0.503 | 92.5 |
| | 1:8 | 0.272 | 0.233 | 85.7 |
| | 1:16 | 0.136 | 0.109 | 80.1 |
| | | | | |
| 2 | | | 0.508 | |
| | 1:2 | 0.254 | 0.247 | 97.2 |
| | 1:4 | 0.127 | 0.118 | 92.9 |
| | 1:8 | 0.064 | 0.058 | 90.6 |
| | 1:16 | 0.032 | 0.031 | 96.9 |

## Recovery

Six saliva samples containing different levels of endogenous cortisol were spiked with known quantities of cortisol and assayed.

| Sample | Endogenous (µg/dL) | Added (µg/dL) | Expected (µg/dL) | Observed (µg/dL) | Recovery (%) |
|--------|--------------------|---------------|------------------|------------------|--------------|
| 1 | 0.088 | 2.000 | 2.088 | 2.176 | 104.2 |
| 2 | 0.077 | 0.300 | 0.377 | 0.380 | 100.8 |
| 3 | 0.062 | 0.011 | 0.073 | 0.071 | 97.3 |
| 4 | 0.066 | 2.500 | 2.566 | 2.723 | 106.1 |
| 5 | 0.210 | 0.300 | 0.510 | 0.508 | 99.6 |
| 6 | 0.086 | 0.011 | 0.097 | 0.094 | 96.9 |

## Precision

1. The intra-assay precision was determined from the mean of 14 (low) and 18 (high) replicates each.

| Sample | N | Mean (µg/dL) | Standard Deviation (µg/dL) | Coefficient of Variation (%) |
|--------|---|--------------|-----------------------------|-------------------------------|
| Level 1 | 18 | 0.999 | 0.033 | 3.35 |
| Level 2 | 14 | 0.097 | 0.004 | 3.65 |

2. The inter-assay precision was determined from the mean of average duplicates for 12 separate runs.

| Sample | N | Mean (µg/dL) | Standard Deviation (µg/dL) | Coefficient of Variation (%) |
|--------|---|--------------|-----------------------------|-------------------------------|
| Level 1 | 12 | 1.020 | 0.038 | 3.75 |
| Level 2 | 12 | 0.101 | 0.006 | 6.41 |

## Specificity of Antiserum

| Compound | Spiked Concentration (ng/mL) | % Cross-reactivity in HS Salivary Cortisol EIA |
|---|---|---|
| Prednisolone | 100 | 0.568 |
| Prednisone | 1000 | ND |
| Cortisone | 1000 | 0.130 |
| 11-Deoxycortisol | 500 | 0.156 |
| 21-Deoxycortisol | 1000 | 0.041 |
| 17α-Hydroxy-progesterone | 1000 | ND |
| Dexamethasone | 1000 | 19.2 |
| Triamincinolone | 1000 | 0.086 |
| Corticosterone | 10,000 | 0.214 |
| Progesterone | 1000 | 0.015 |
| 17 β-Estradiol | 10 | ND |
| DHEA | 10,000 | ND |
| Testosterone | 10,000 | 0.006 |
| Transferrin | 66,000 | ND |
| Aldosterone | 10,000 | ND |

ND = None detected (<0.004)

# Salivary Cortisol Expected Ranges

Each laboratory should establish its own range of expected values.  The following values have been reported for salivary cortisol.

| Group | Number | Overall Range (µg/dL) |
|---|---|---|
| Children, neonatal | 275 | ND - 3.417 |
| Children, age 6 months | 165 | ND - 2.734 |

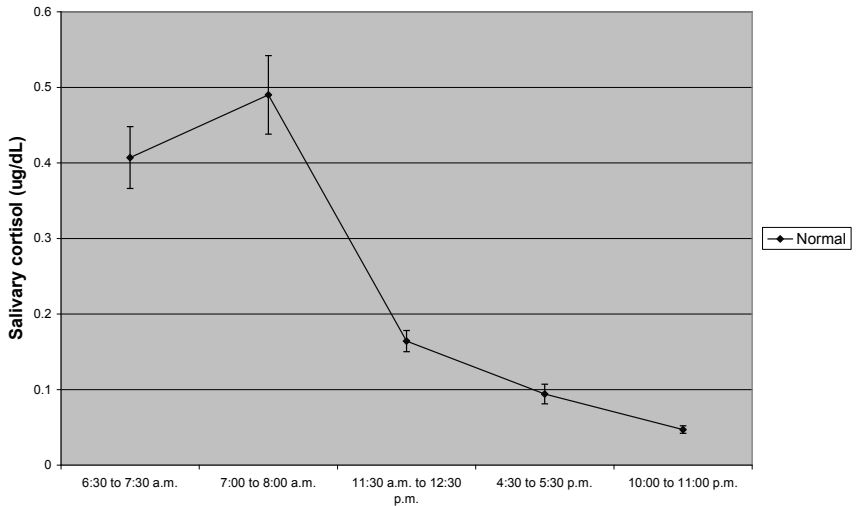| Group | Number | AM Range (µg/dL) | PM Range (µg/dL) |
|---|---|---|---|
| Children, ages 2.5-5.5 | 112 | 0.034 - 0.645 | 0.053 - 0.607 |
| Children, ages 8-11 | 285 | 0.084 - 0.839 | ND - 0.215 |
| Adolescents, ages 12-18 | 403 | 0.021 - 0.883 | ND - 0.259 |
| Adult males, ages 21-30 | 26 | 0.112 - 0.743 | ND - 0.308 |
| Adult females, ages 21-30 | 20 | 0.272 - 1.348 | ND - 0.359 |
| Adult males, ages 31-50 | 67 | 0.122 - 1.551 | ND - 0.359 |
| Adult females, ages 31-50 | 31 | 0.094 - 1.515 | ND - 0.181 |
| Adult males, ages 51-70 | 28 | 0.112 - 0.812 | ND - 0.228 |
| Adult females, ages 51-70 | 23 | 0.149 - 0.739 | 0.022 - 0.254 |
| All adults | 192 | 0.094 - 1.551 | ND - 0.359 |

| Group | Number | 2300h (ug/dL) |
|---|---|---|
| Normal subjects | 19 | 0.007 – 0.115 |
| Cushing's subjects | 21 | 0.130 – 2.972 |

ND = None detected

Expected ranges for neonates to 5.5 years were derived using the Salimetrics Salivary Cortisol Immunoassay Kit.

Expected ranges for 8 to 18 years were reported from an unpublished manuscript, Pennsylvania State University's Behavioral Endocrinology Laboratory.   Adult ranges were obtained from published literature. (22)

**Normal Diurnal Cortisol (Salivary)**



**Note:** Time of cortisol peak will vary in individual patients relative to their normal wake-up time.

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# Seller's Limited Warranty

"European Authorized Representative"
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