



## Reference Ranges and What They Mean

### The "Normal" or Reference Range

In reference to a lab test, what does "Out of the normal range" actually mean? Is it cause for concern?

The brief answer is that a result out of the normal range signals the need for further investigation – or at least further explanation. Interpreting any clinical laboratory test involves comparing the patient's results to the test's "reference range" also commonly called the "normal range" or "reference interval."

### What is a reference range?

Some tests provide a simple yes or no (positive or negative, reactive or non-reactive) answer. Was the urine or blood pregnancy test positive for pregnancy (indicating the presence of a hormone called HCG) or negative (absence of HCG)? Did the test find antibodies to a virus or bacterium that indicates an infection? Some labs report these tests as reactive (positive) or non-reactive (negative).

More commonly, the meaning of test results depends on their context. A typical lab report will provide your results followed by a reference range. For example, your results for a thyroid-stimulating hormone (TSH) test might look something like: 2.0 mIU/L (ref range 0.5 – 5.0 mIU/L). The test results indicate that your result falls within the normal range.

How was that reference range established? The short answer is: by testing a large number of healthy people and observing what is "normal" for them. The first step in determining a given reference range is to define the population to which the reference range will apply – for example, healthy females aged 20-30 years old. A large number of individuals from this category would be tested for a specific laboratory test. The results would yield a "normal" distribution and a reference range (plus or minus 2 standard deviations of the average) of normally distributed values would be established.

The term "reference range" is preferred over "normal range" because the reference population can be clearly defined. Rather than implying that the test results are being compared with some vague definition of "normal," the reference range means the results are being considered in the most relevant context. When you examine test results from different populations, you quickly discover that what is "normal" for one group is not necessarily normal for another group. For example, pregnancy changes many aspects of the body's chemistry, so pregnant women have their own "normal range" for many lab tests that vary greatly from non-pregnant women of the same age.

Finally, reference ranges are specific to the laboratory that produces the test results. For many test specimens ("analytes"), different laboratories use different kinds of equipment and different methods of testing. This means that each laboratory must establish its own reference ranges using data from its own equipment and methods. The laboratory must supply your test result with an accompanying reference range on the laboratory report. *Consequently, there is no such thing as a standard reference range.*

Of course, each test does have a theoretical reference range, which can be found in many books and online sources, but it may have little diagnostic meaning for you. You and your doctor should apply the reference range supplied by the laboratory performing the test.

### **Effects of Age and Sex**

For many tests, there is no single reference range that applies to everyone because the tests performed may be affected by the age and sex of the patient, as well as many other considerations. Therefore, as part of the specimen collection and submission process and the subsequent reporting of results, age, sex and other factors come into play in establishing the "normal or reference range" and will be listed on the results sheet along with the results to allow proper interpretation.

Laboratories will generally report the findings based on age and sex, and leave it to the physician to interpret the results based on factors such as diet, your level of activity, or medications you are taking. *If you know of any special circumstances that could affect a test, mention them to your doctor; don't assume your doctor has thought of every possible circumstance.* For example: Did you run a marathon yesterday? Have you started a new supplement, medication or extreme diet?

### **Other Factors Affecting Test Results**

Laboratories will generally report your test results accompanied by a reference range keyed to your age and sex. Your physician will still need to interpret the results based on personal knowledge of your particulars, including any medications or herbal remedies you may be taking. A plethora of additional factors can affect your test results: your intake of caffeine, tobacco, alcohol or vitamin C; your diet (vegetarian vs. carnivorous); stress or anxiety; or a pregnancy. Such factors as occupation, altitude, and distance from the ocean have been known to affect results. Regular exercise can also affect values.

All these considerations underscore the importance of taking blood or urine samples in a standardized fashion for performing and interpreting laboratory tests (and home tests as well). It's important to comply with your doctor's instructions in preparing for the test, such as coming in first thing in the morning before you eat anything to get your blood drawn. That compliance makes your sample as close as possible to others; it keeps you within the parameters of your reference group.

### **What does it mean if my test result is out of the reference range?**

By definition, 1 out of 20 (or 5%) results will fall outside the established reference range with specimens taken from a random sample of healthy individuals. Generally, if the test value is only slightly higher or lower than the reference range, there is usually no reason for alarm.

If your doctor suspects that the result may indicate a problem, the first action is usually to rerun the test. As accurate as modern lab tests are under optimal testing circumstances, many factors that you or your doctor cannot control (heat, humidity, transport time, etc.) can affect any given test results.

### **In summary**

Remember, an "abnormal" or "outside the reference range" test result is not always a sign of a problem. A test result outside the reference range may or may not be a reason for concern; you could even be "better than expected" and still fall outside the expected statistical range. Although you can have an "abnormal" or "outside the reference range" value and have nothing wrong; usually your doctor should try to determine the cause if the reason is not readily apparent.

If test results are outside the reference range, your doctor may want to rerun the test. Some abnormal results may disappear on their own, especially if they are on the border of the reference range. A key point your doctor will address is how far out of the reference range the result is. If these investigations point to a problem, then your doctor will address it. But very few medical questions can be answered by a single test.

Conversely, if all your test results are normal, you are not guaranteed to be "bullet-proof." If you're trying to follow a healthy lifestyle, take it as a good sign and keep it up. But if you're engaging in high-risk behavior, such as drug and alcohol abuse or a poor diet, it only means "so far so good," and the potential consequences haven't caught up with you yet. A good test result is not a license for an unhealthy lifestyle. A few tests over time are more accurate than a single snapshot.

If you previously had abnormal results, normal results certainly provide good news. But your doctor may want to conduct follow-up tests some months later to make sure you're still on track and to document any trends.

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