

# Blood Chemistry and Health: One Person's Experience.

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Joan Davidson recently turned 40 years old. Her knees ache, and she feels short of breath during exercise. She is experiencing fatigue and often feels that she is going in slow motion. Periodic dizziness plagues her during most days. According to the drugstore machine, her blood pressure is elevated. Her family has a history of cardiac disease, with both of her parents having experienced heart attacks. Additionally, an aunt on her mother's side has diabetes. Hypothyroidism also runs throughout her immediate family. Joan is approximately 20 pounds overweight. She has tried various diet and exercise programs in an attempt to lose weight. Her results have been disappointing.

With the advice of her physician, she scheduled an appointment for a full physical exam, including a complete blood workup. Her doctor is particularly interested in the level of various blood components that might shed some light on Joan's reported symptoms. Specifically, he wants to exam her white blood cell count, red blood cell count, hemoglobin and hematocrit figures for indications of infection or anemia. Her serum glucose level will provide information concerning the possibility of the onset of diabetes. Cholesterol and triglyceride levels

will provide insight into potential cardiac problems. Additionally, the possibility of hypothyroidism will be investigated by examining Joan's serum TSH level.

As instructed, two week before her doctor's appointment, she reported to her doctor's lab for a blood test. She confirmed for the lab technician that she had fasted for the twelve hours immediately preceding the exam.

During her physical, Joan's doctor reviewed the blood test report with her. He expressed concern over some of the results, but Joan was not convinced that she had a problem. Additional blood tests were not a viable option because it takes a good deal of time to get a sample of readings and they are expensive. At the time of her doctor's appointment, she was unwilling to accept the offered prescriptions. She chose to do a little research before committing herself to any drug regimen.

Her research revealed that many medical measurements, such as cholesterol, are normally distributed in healthy populations. Unfortunately, the lab report did not provide the means and standard deviations necessary for Joan to calculate the various probabilities of interest. However, the report did provide

the appropriate reference intervals. Assuming that the reference intervals represent the range of values for each blood component for a healthy adult population, it is possible to estimate the various means and standard deviations for this population. Joan estimated each mean by taking the midpoint of its reference interval. Using the Range Rule of Thumb ( $\sigma = \text{range}/4$ ), she estimated standard deviations by dividing the reference interval by 4. The included table lists Joan's blood test results, as well as the mean and standard deviation for a number of blood test components for the population of normal healthy adults.

For each blood component measurement, Joan decided to determine the z score. This would tell her how far away from the average each of her blood measurements were. She knew that 95% of a healthy population's blood measurements would be within a z score of plus or minus 2 (2 standard deviations). She reasoned that any of her blood measurements that were farther away than 2 standard deviations from the population's average should be considered unusual and might be cause for concern.

Test Component	Units	Population Mean based on midpoint of interval	Population Std Deviation based on Range Rule of Thumb	Joan's Result	Z-score
White blood cell count	103/mL	7.25	1.63	5.30	.1151 or -1.20
Red blood cell count	106/mL	4.85	0.38	4.62	.2709 or -0.61
Hemoglobin	g/dL	14.75	1.13	14.60	.4483 or -0.13
Hematocrit	%	43.00	3.50	41.70	.3557 or -0.37
Glucose, serum	mg/dL	87.00	11.00	95.00	.7673 or 0.73
Creatine, serum	mg/dL	1.00	0.25	0.80	.2090 or -0.8
Sodium, serum	mEq/L	141.50	3.25	143.00	.9987 or 3
Potassium, serum	mEq/L	4.50	0.50	5.10	.8869 or 1.2
Chloride, serum	mEq/L	102.50	3.25	100.00	.2206 or -0.77
Carbon dioxide, total	mEq/L	26.00	3.00	25.00	.3707 or -0.33
Calcium, serum	mg/dL	9.55	0.53	10.10	.8508 or 1.04
Total cholesterol	mg/dL	149.50	24.75	253.00	.9999 or 4.18
Triglycerides	mg/dL	99.50	49.75	150.00	.8461 or 1.02
HDL cholesterol	mg/dL	92.50	28.75	42.00	.0392 or -1.76
LDL cholesterol	mg/dL	64.50	32.25	181.00	.9999 or 3.61
LDL/HDL ratio	Ratio	1.80	0.72	4.30	.9997 or 3.47
TSH, high sensitivity, serum	mIU/ML	2.93	1.29	3.15	.7157 or 0.57

## Assignment

1. Joan found that the reference interval for HDL cholesterol was 35 – 150 mg/dL.

Use this information to confirm the mean and standard deviation for this blood component indicated in the table. Show your handwritten work here:

usual range is equal to the mean + 20.

$$(92.5) + 2(28.75) = 150 \text{ mg/dL}$$

$$(92.5) - 2(28.75) = 35 \text{ mg/dL}$$

2. In the data table, in the column to the right of Joan's results, use **Z Score** for the column heading. Calculate and record the z score for each of Joan's test measurements.

In the area below, show your calculation steps of z scores for any 4 of the measurements.

1.  $(5.30 - 7.25) / 1.63 = -1.196$  or roughly .1151

2.  $(4.62 - 4.85) / 0.38 = -0.61$  or roughly .2709

3.  $(14.06 - 14.75) / 1.13 = -0.13$  or roughly .4483

4.  $(41.70 - 43.00) / 3.50 = -0.37$  or roughly .3557

- Using Joan's criteria and the information provided in her blood test report, determine which blood components are sources of concern for her. List them below and for each one, provide a brief, 1 sentence explanation of why Joan should be concerned.

-Her total cholesterol was extremely high, it was more than 2 standard deviations away from the mean.

-Her HDL cholesterol which is the good kind of cholesterol, was too low for where her average should be.

-Her LDL cholesterol was very very high (bad cholesterol), it was more than 2 standard deviations away from what her average should be.

-Lastly her LDL/ HDL ration was a little higher than the average and gives us some reason to be concerned.

- On a separate page, compose and type a 2 paragraph (at least 3 sentences each) summary of your findings. List your assumptions and the limitations of your conclusions.

The z scores were easy to find as long as you plug in the correct numbers to the correct place of the formula. The z score is the end result every time. In question number one, the standard deviation and mean are correct.

It seems that Joan needs to really pay attention to both of her cholesterol levels in all the forms listed. We think that if she were able to get those back to reasonable levels, she would feel better in the reasons of her visit to her physician. She may even be able to loose the extra 20 pounds that she is dealing with. That being said, there may be other underlying problems that have to do with genetics. That is hard to do with the knowledge that is available to us.

This case study is based on:

***A Tale of Blood Chemistry and Health*** from:

Michael Sullivan, I. (2013). *Statistics: Informed Decisions Using Data*, 4/E. Pearson Higher Ed.