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Tyroid cancer and iodine levels

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Abstract

Medical researchers at the UCLA Medical Center Endocrinology Clinic are planning a study investigating iodine levels of thyroid cancer patients. We provided them with a power analysis in order to help them determine the sample size required for certain effect size and power combinations.

1 Introduction

The motivation of this study is the increasing incidence of thyroid cancer in the United States. Researchers hypothesize that there may be a link between excessive iodine intake and the increased rate of thyroid cancer. In order to study the relationship they will be collecting data on iodine levels and thyroid nodules from patients visiting the UCLA Medical Center. However before data collection begins, we need to first do a power analysis to determine the sample sizes necessary to produce estimates of adequate precision.

The main goal of this study is to see if there is a significant relationship between iodine levels and thyroid cancer. For this 24hr urinary samples from patients with newly diagnosed thyroid nodules will be collected and analyzed for amounts of iodine. 24hr urinary iodine excretion has been shown to be a good measure of overall levels of iodine in an individual and has been used in multiple other studies as the gold standard to assess for iodine deficiency/excess.

The Endocrinology clinic at the UCLA Medical Center sees approximately 2 patients per week with new thyroid nodules. These patients are all subsequently sent for thyroid ultrasound and biopsy of the lesion. Therefore it is possible to compare the pathology results to the iodine levels of the patients. It is expected that patients with biopsy confirmed thyroid cancer would have evidence of iodine excess compared to those with normal biopsies.

In summary, there are two groups that will be compared: those with newly diagnosed thyroid nodules that are malignant (`cancer`) and those with newly diagnosed thyroid nodules that are benign (`no cancer`).

2 Methodology

The hypotheses that we are testing are:

H_0 : Mean iodine level of the patients in the `cancer` and `no cancer` groups are equal.

H_A : Mean iodine level of the patients in the `cancer` group is higher than the patients in the `no cancer` group.

It should be noted that the power analysis conducted assumed this one-tailed alternative and allowed no power to test if the `no cancer` group has a higher mean iodine level than the `cancer` group. Differences in iodine levels ranging from 20 to 50 $\mu g/24hr$ were used to calculate achieved power.

In doing the power analysis, we assumed that the size of the `no cancer` group is 19 times the size of the `cancer` group. This was based on the client's input that about 5% of the patients coming to the clinic with new thyroid nodules have nodules that are malignant. We looked at achieved power when the size of the `cancer` group ranged from 5 to 50 and the `no cancer` group ranged from 95 to 950.

We also assumed that the standard deviations of iodine levels in the two groups is approximately 70 $\mu g/24hr$ (Lawrence et al., 2000). Similar standard deviations were seen elsewhere in the literature (Manz et al., 2002)

Analysis was done using the `pwr.t2n.test` function in the `pwr` package using `R` statistical software. For more information on the algorithm, see the package vignette (Champely, 2009).

3 Results

The plots in Figure 1 show the sample sizes needed in the `cancer` group for given effect sizes and desired achieved power.

From these figures, we can see that

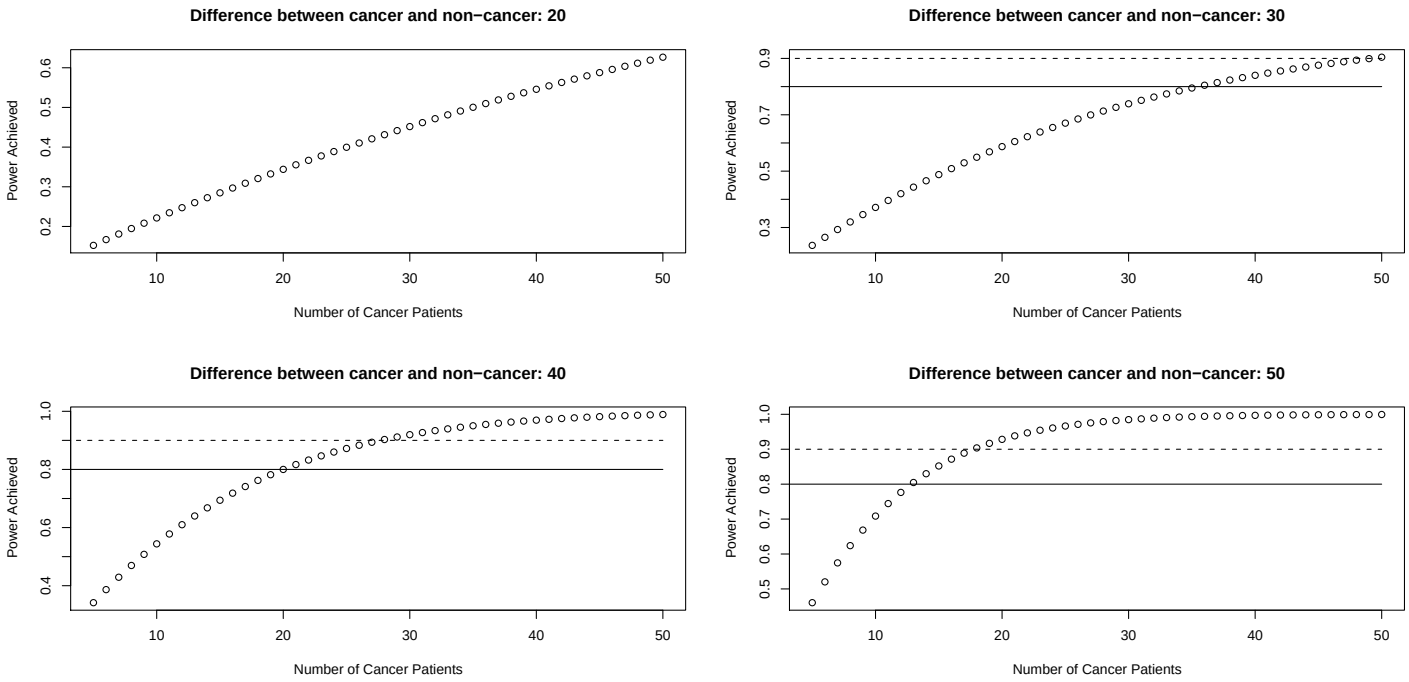

Figure 1: Sample sizes required for given effect size and power combinations

- For a difference of 20 $\mu g/24hr$, a sample size greater than 50/950 `cancer`/`no cancer` would be required to achieve 80% power.
- For a difference of 30 $\mu g/24hr$, a sample size of 36/684 would be required to achieve 80% power and a sample size of 50/950 would be required to achieve 90% power.
- For a difference of 40 $\mu g/24hr$, a sample size of 20/380 would be required to achieve 80% power and a sample size of 28/532 would be required to achieve 90% power.
- For a difference of 50 $\mu g/24hr$, a sample size of 13/247 would be required to achieve 80% power and a sample size of 18/342 would be required to achieve 90% power.

4 Summary

The power achieved by the given test depends upon the sample sizes, the standard deviation of the samples, and the differences in sample means ("effect size"). This report presents the calculated power under a set of scenarios. Additional scenarios can be analyzed in a similar manner, but a few general trends will emerge:

- Holding standard deviation and effect size constant, power increases as sample size increases.
- Holding effect size and sample size constant, power decreases as standard deviation increases.
- Holding standard deviation and sample size constant, power increases with effect size.

5 References

Champely, S. (2009). *Package 'pwr'*. CRAN. http://cran.r-project.org/web/packages/pwr/pwr.pdf.

Lawrence, J., Lamm, S., S., P., K., R., & Braverman, L. (2000). The effect of short-term low-dose perchlorate on various aspects of thyroid function. *Thyroid*, *10*(8), 321–359.

Manz, F., Böhmer, T., Gärtner, R., Grossklaus, R., Klett, M., & Schneider, R. (2002). Quantification of iodine supply: Representative data on intake and urinary excretion of iodine from the german population in 1996. *Annals of Nutrition and Metabolism*, *46*, 128–138.