Systematic Review of Magnesium Levels

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Introduction

The end goal of this project is to determine a reference range for ionized magnesium and total magnesium concentrate in people with different health conditions. The results from a number of studies have been compiled, and our initial objective is to combine the means and standard deviations from those seperate studies. The initial collection of data includes studies of people with five different health conditions.

- diabetes
- hypertension
- renal disease
- cardiovascular disease
- healthy

For each health condition, there are two measurements.

- ionized magnesium
- total magnesium concentration.

The Data

The data set contains one observation for each study/group/condition/measurement combination. Not all conditions are included in all studies. For example, there are 23 study/group observations reporting ionized magnesium in people with cardiovascular disease, but only one reporting total magnesium in people with hypertension. Studies range in size from samples of 6 to 1,652 people. For each study, we should have sample size, mean, and standard deviation or standard error. The initial data set includes 219 observations. In the cases where the mean or sample size is missing, there is no way to include the observation in a weighted mean. This includes 5 rows which must be excluded from all calculations. There remain 9 observations with no standard deviation. We have managed this discrepancy in two different ways, explained in the Methods section.

The Math

The weighted means are calculated using the formula

$$\bar{x}_t = \frac{1}{n_t - 1} \sum_{i=1}^{k} \bar{x}_i \times n_i \quad \text{where} \quad n_t = \sum_{i=1}^{k} n_i$$

The weighted standard deviations are calculated using the formula

$$s_t = \sqrt{\frac{\sum_{i=1}^{n}((n_i - 1) \times s_i^2 + n_i \times \bar{x}_i^2) - n_i \times \bar{x}_t^2}{n_t - 1}}$$

Two Methods

In our first method, we started by removed the observations with missing standard deviations. We then calculated the weighted mean ($\bar{x}_t$) and weighted standard deviations (s_t) without those observations.

In our second method, we calculated the weighted mean using all observations for which we had both sample size and mean. We then removed the 22 observations with no standard deviation, recalculated the total sample sizes (n_t), and calculated the weighted standard deviation. In our opinion, this is a valid method for analysis and is preferred, as it includes as much information as is available. Upper and lower bounds are then calculated for all conditions and metrics.

The Results

Method 1

health condition	metric	mean	sd	lower	upper
CVD	iMg	0.5043529	0.0737622	0.3597791	0.6489267
CVD	Total Mg	0.8110504	0.1153862	0.5848933	1.0372074
Diabetes	iMg	0.4617094	0.1028949	0.2600353	0.6633834
Diabetes	Total Mg	0.8470795	0.1228532	0.6062872	1.0878718
Healthy	iMg	0.5396566	0.0612668	0.4195737	0.6597394
Healthy	Total Mg	0.8529319	0.0651624	0.7252137	0.9806501
Hypertension	iMg	0.6419046	0.1233895	0.4000612	0.8837479
Hypertension	Total Mg	0.9388394	0.0770000	0.7879194	1.0897594
Renal disease	iMg	0.5711129	0.1030334	0.3691674	0.7730584
Renal disease	Total Mg	0.9414096	0.1910850	0.5668831	1.3159361

Method 2

health condition	metric	mean	sd	lower	upper
CVD	iMg	0.5043529	0.0737622	0.3597791	0.6489267
CVD	Total Mg	0.8110504	0.1153862	0.5848933	1.0372074
Diabetes	iMg	0.4617094	0.1028949	0.2600353	0.6633834
Diabetes	Total Mg	0.8470795	0.1228532	0.6062872	1.0878718
Healthy	iMg	0.5373928	0.0737674	0.3928087	0.6819769
Healthy	Total Mg	0.8511375	0.0804833	0.6933902	1.0088847
Hypertension	iMg	0.6419046	0.1233895	0.4000612	0.8837479
Hypertension	Total Mg	0.9388394	0.0770000	0.7879194	1.0897594
Renal disease	iMg	0.5756440	0.0723579	0.4338225	0.7174654
Renal disease	Total Mg	0.9479607	0.1524165	0.6492245	1.2466970