Systematic Review of Ionized Magnesium

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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.

Additionally, the data includes total serum magnesium concentration for healthy individuals.

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 24 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. 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 28 rows which must be excluded from all calculations. A number of observations have a reported standard error, but no standard deviation. In those cases, the standard deviation has been calculated using the formula $s = s_{\bar{x}} \times \sqrt{n}$ After making this calculation, there remain 22 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

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

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 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	0.5042513	0.0718118	0.3635002	0.6450024
CVD	Total Mg	0.8416867	0.0984950	0.6486366	1.0347369
Diabetes	iMg	0.4984512	0.1369067	0.2301140	0.7667883
Diabetes	Total Mg	0.8462500	0.1126498	0.6254563	1.0670437
Healthy	iMg	0.5414568	0.0658656	0.4123601	0.6705534
Healthy	Serum Mg	0.8172414	0.0550000	0.7094414	0.9250414
Healthy	Total Mg	0.8563636	0.0701466	0.7188764	0.9938509
Hypertension	iMg	0.6433406	0.1283642	0.3917467	0.8949344
Hypertension	Total Mg	0.9348187	0.0800000	0.7780187	1.0916187
Renal disease	iMg	0.5732497	0.1035237	0.3703432	0.7761562
Renal disease	Total Mg	0.9408775	0.1895157	0.5694267	1.3123283

Method 2

health condition	metric	mean	sd	lower	upper
CVD	iMg	0.5042513	0.0718118	0.3635002	0.6450024
CVD	Total Mg	0.8416867	0.0984950	0.6486366	1.0347369
Diabetes	iMg	0.4984512	0.1369067	0.2301140	0.7667883
Diabetes	Total Mg	0.8462500	0.1126498	0.6254563	1.0670437
Healthy	iMg	0.5387104	0.0797954	0.3823114	0.6951094
Healthy	Serum Mg	0.8172414	0.0550000	0.7094414	0.9250414
Healthy	Total Mg	0.8542340	0.0872844	0.6831567	1.0253114
Hypertension	iMg	0.6433406	0.1283642	0.3917467	0.8949344
Hypertension	Total Mg	0.9348187	0.0800000	0.7780187	1.0916187
Renal disease	iMg	0.5772821	0.0767634	0.4268259	0.7277382
Renal disease	Total Mg	0.9474482	0.1504210	0.6526231	1.2422732