IMPORTANCE OF BIOSTATISTICS IN THE EVALUATION OF DIETS IN GROUPS OF INDIVIDUALS

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Abstract: In the dietary assessment of a group of individuals it must be considered the variances of daily consumption and differences in food choices among individuals. Therefore, the purpose of this paper is to evaluate the food consumption of obese and control schoolchildren by adjusting the intra e interpersonal variances.

Keywords: dietary assessment, group of individuals, variances analysis

1. INTRODUCTION

In nutrition researches that aim the dietary assessment of a group of individuals, it is of extreme importance the assessment of the nutritional quality of the diet and nutritional status. For the diet evaluation, the requirement of nutrients and energy of the group to be analyzed must be considered. The requirements are determined by variables of age, sex, stage of life, physical activity and body measurements in healthy individuals[1, 2].

For the evaluation of the diet, reference values for nutrients are established to be compared with the amount of nutrient consumed by the group. The Dietary Reference Intakes (DRIs) have been used lately; they are a revision of the recommendation of nutrients and energy adopted by the United States of America (USA) and Canada, considered the old RDA (recommended dietary allowance) from U.S. and the old RNIs (Recommended Nutrient Intakes) from Canada[3,4].

The DRIs are different because they specify data on safety and efficiency, reduction on the risk of chronic non-degenerative diseases such as cancer, obesity, diabetes, rather than just focus on the absence of signs of deficiency. The DRIs also set the upper levels in order to prevent any risk of adverse effects[2,3,5].

The DRIs are reference values for quantitative intake of nutrients that should be used for planning and assessment of diets for healthy people. This includes intake recommendations, such as the upper bounds.

Judgment is required for the scientific use of reference values, as there are nutrients with limited data, or its information is taken from studies that have methodological limitations [3,5].

The DRIs include the RDA (recommended dietary allowance, AI (adequate intake), EAR (estimates average requirement) and UL (tolerable upper intake level):

- EAR = is a usual average consumption value that is estimated to meet the requirement of nutrient of half the population (50%) in a life stage and gender groups. At this level of consumption, the other half of the population in specified group would not have their needs met. The EAR is based on a specific criterion of adequacy, derived from a careful review of the literature. It coincides with the mean when the distribution is asymmetric. The EAR is used to calculate the RDA [3-5].

- RDA = The RDA is the level of average daily intake that is sufficient to meet the nutritional needs of almost all healthy individuals in a particular life stage and gender [3-5].

- AI = The value of AI is used when it is not possible to establish an EAR and therefore RDA. AI is based on experiments or observations of average consumption of a group of apparently healthy people, with features such as normal growth, maintenance of normal nutrients levels in plasma, and other aspects of nutritional well-being or health in general [3-5].

- UL = is defined as the highest value of prolonged intake of a nutrient that apparently poses no adverse health effects in almost all individuals in a life stage or gender [3-5].

To assess food consumption of individuals, the EAR and UL are more appropriate references for diets evaluation. Consumption figures below the EAR indicate high probability of inadequacy, and above the UL, the risk of developing adverse effects[2].

Several limitations should be taken into consideration during the evaluation of the diet, such as the memory of the individual, ie, memory to recall the food consumed, the ingredients of the preparation, portion sizes[3,6]. To
improve the accuracy of those records, it is indicated the use of household measures (eg, cutlery and table service), photo albums with portion sizes and models of food portions that help prevent forgetfulness[3,6-8]. The underreporting is not only an unconscious problem[3,9].

But it is also conscious, when the report of the data is too laborious or when the individual feels ashamed to report “unhealthy” food[3,9]. For this reason, some studies and institutes have brought a new focus for the interviews of food consumption in order to avoid underestimation and overestimation of the amount of food consumed[10,11].Despite these limitations, the evaluation of the diet should be as accurate as possible.

For verification of diet adequacy, it is necessary to know the food that is regularly consumed by the individual, therefore at least two days of consumption information is needed. The Institute of Medicine recommends the use of a 24-hour dietary recall, in which the person has to report everything they have eaten in the previous 24 hours. One of the advantages of this method is the use of recent memory[1,3].

As already mentioned, during the diet’s assessment of a group of individuals, the accuracy of the data is continually sought. But it’s important to remember that there are variations in consumption between people due to different eating habits, lifestyle (working out, housewife), food taboos and different offspring that influence food choices. Moreover, there is an intra-personal variation, which means the food choices an individual make may vary from one day to another[1,12,13,14].

Thus, the average intake of a nutrient is influenced by the effect of variation of each individual in the population (interpersonal variance-Sb²) and the variation from day to day (intra-personal variance - Sw²). Currently, the researchers focused on nutrition have been discussing statistical methods that are able to remove this variation from day to day, checking only the variation between individuals, thereby obtaining more accurate data[1,15,16].

In the different sections will discuss the following topics of the study: 2 – purpose that motivated the present study, 3 - methodology that was used in the study, 4 – results found, 5 - Discussion, 6 – Conclusion and considerations for future studies, Acknowledgments.

2. PURPOSE

This paper aims to verify the effect of removal of intra-personal variance in the adequacy of micronutrient’s intake (vitamin C) in overweight children compared to a control group.

METHODS

This cross-sectional study derived from a research project titled “Risk factors for chronic diseases in obese children” was developed in Piracicaba, SP, with schoolchildren from 7 to 11, enrolled in 6 public schools located in the five regions of the city21. The children were recruited from a nutritional assessment study in progress in 2005. In these schools, 159 children were identified with overweight. For pairing sample, 159 children with normal weight and height by age and gender were invited to participate in the study as a control group. But only 100 answered the call, and these were divided between the control group (n = 58) and overweight group (n = 42). Seeking to minimize the effects of gender and age on the results, the groups were matched according to these variables, which resulted in 42 children in the control group. Therefore, we studied 84 children, 58.3% were female, 61.9% in the control group and 54.8% in the overweight group. In both groups, the mean age was 8.9 ± 1.0.

The classification of obesity was made from the body mass index (BMI), BMI = weight/ (height)², according to the criteria and distribution percentiles for the reference population from the National Center for Health Statistics - NCHS. Obesity was characterized by percentile of BMI for age> 95 and children in the control group by percentile of BMI for age between 5 and 85.

Before starting the study with children, this project was submitted for approval by the Ethics Committee in Research at the Faculdade de Ciências Farmacêuticas - UNESP - Araraquara, receiving the assent to its implementation (opinion No. 31/2005).

Dietary intake was assessed by two 24 hours non-consecutive food records. Students were asked to report everything that had been consumed within 24 hours prior to each interview. The notes were made by the same interviewer, with the help of an album of photographs and models of appliances. The amount of food consumed was recorded in household measures, transformed into grams and then launched into the program of Nutrition support NutiWin ® (ref) to estimate the intake of micronutrients. Vitamin C (mg) was the micronutrient.

To assess the adequacy of intake of these micronutrients, the EARs (Estimated Average Requirement) of the DRIs (Dietary Reference Intake) were used. The EARs can be defined as the average nutrient amount for a given stage of life and gender. It is a value of reference that was used to be compared to the mean amount of micronutrients consumed by the groups of children.

Then, to estimate the proportion of individuals consuming above or below the EAR, considering the variation of inter-and intra-personal consumption, we applied statistical
method to remove the variability from day to day, reflecting only the change in consumption between individuals of the group.

Initially, it was necessary to determine whether the distribution of usual intake was normally distributed, otherwise, it would be necessary to apply a transformation to remove the asymmetry, such as logarithmic application, which was not necessary.

For the removal of the personal variation, it is necessary to obtain the intrapersonal (Sw2) and interpersonal (Sb2) variances. Through the ANOVA (analysis of variance), it is possible to obtain these data.

According to Slater et al. (2004) estimates of these variances are calculated according to the following relations:

**Step 1:**

\[ \text{ESM}_w = S_{w2} \]

\[ \text{ESM}_b = S_{w2} + K S_{b2} \]

**Step 2:**

\[ S_{b}^2 = \left( \frac{\text{ESM}_b - S_{w2}^2}{K} \right) \]  

**Step 3:**

\[ S_{ob} / S_b = (1 + S_w^2 / K (S_b^2))^{1/2} \]

**Step 4:**

inversion of the equation

\[ S_b / S_{ob} = \left( \frac{69.84701 - 51.67955}{2} \right) = 9.083727 \]

**Step 5:**

adjusted value of the nutrient = medium + (Xi - medium) * Sb/Sob

Medium = medium value of the group; Xi = value of each individual.

Through the adjusted value of each individual nutrient, the adjusted mean of the group can be obtained and set the SD group.

**Step 6:**

\[ Z_{\text{adjusted}} = \frac{(\text{EAR} - \text{Medium}_{\text{adjusted}})}{Sd_{\text{adjusted}}} \]

The value of Z adjusted is obtained by values from EAR of DRIS, from adjusted medium and from adjusted SD of the groups.

**Step 7:**

Make the construction of the distribution curve through the value of Z adjusted, verifying thus the probability of adequacy of consumption. To calculate the area of the curve that corresponds to the proportion of individuals with inadequate intake, it is necessary to use the normal curve reduced.

Example:

Prevalence of the adequacy of Vitamin C intake in school children from the control group, using two 24-hour dietary recall non-consecutive. After the analysis of variance (ANOVA), the following data was obtained:

(see chart 2)

\[ S_{w2} = 51.67955 \]

\[ S_{b}^2 = \left( \frac{69.84701 - 51.67955}{2} \right) = 9.083727 \]

\[ S_{ob} / S_b = (1 + 51.67955 / 2(9.083727))^ {1/2} = 1.960771 \]

\[ S_b / S_{ob} = 0.510003 \]

Adjusted value of the nutrient = 15.7 + (Xi - 15.7) * 0.510003
4. RESULTS:

Regarding the consumption of vitamin C by the control group, the median intake was 60.5 mg, the median EAR reference was 33.9 mg. In this group, the consumption of vitamin C was adequate in 68.2% (Z = -0.47; SD = 55.9 mg) (figure 5). When the intake of vitamin C was adjusted, the adequacy intake increased to 77.8% (Z = -0.77; SD = 34.7 mg) in the control group (figure 6).

### Chart 1 - ANOVA – Analysis of variance

<table>
<thead>
<tr>
<th>source of variation</th>
<th>DF (degrees of freedom)</th>
<th>SM (square mean)</th>
<th>ESM (Expected square mean)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups – interpersonal</td>
<td>N-1</td>
<td>SMb</td>
<td>Sw2 + k Sb2</td>
</tr>
<tr>
<td>within groups – intrapersonal</td>
<td>N(K-1)</td>
<td>SMw</td>
<td>Sw2</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ESMb: interpersonal square mean
ESMw: intrapersonal square mean
N: Number of individuals
k: Number of repetitions

### Chart 2 - ANOVA – Analysis of variance (Example)

<table>
<thead>
<tr>
<th>source of variation</th>
<th>square’s sum</th>
<th>DF</th>
<th>SM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between groups – interpersonal</td>
<td>2793.88</td>
<td>40</td>
<td>69.84701</td>
</tr>
<tr>
<td>within groups – intrapersonal</td>
<td>2118.862</td>
<td>41</td>
<td>51.67955</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EAR
Mean: 60.5 mg
SD: 55.9 mg
EAR: 33.9 mg/day
z: -0.47
31.8% inadequacy
68.2% adequacy

Figure 5. Consumption of vitamin C in school children from control group
In the overweight group, the median consumption of vitamin C was 62.6 mg. The median reference of EAR of this group was 33.7 mg/day. Without any adjustments, the proportion of children with adequate intake was 70.8% (Z = -0.55, SD = 52.04 mg) (figure 7); Adjusting the variances, the proportion of adequacy increased to 91.7% (Z = -1.39, SD = 20.52 mg) (figure 8).

5. DISCUSSION

In studies directed towards the inquiry of risk factors for chronic diseases (diseases that occur throughout life such as, obesity, hypertension, diabetes and heart disease), feeding is an important variable to be analyzed [17-18]. Among the variables of food, there are data on calorie intake, macronutrients, fat, lipids, proteins and micronutrients such as vitamins (vitamins A, D, C, etc.) and minerals (zinc, iron, calcium, magnesium and etc.) [19]. Therefore, to verify adequacy of the consumption of these macro and micronutrients is important when the objective is to verify the difference in consumption between control subjects for a given disease and individuals who present the disease [20 - 21].

In these investigations, the more accurate the data, more reliable the results will be [3]. One of the factors that can influence the accuracy of data is the intrapersonal variance, as stated previously[1 - 3].

In this study, the chronic disease studied was obesity and after adjusting intrapersonal variance between the groups, the following data was obtained:

Before the intrapersonal adjust of the intake of vitamin C, the consumption’s inadequacy was higher in the control group, however there was a smaller difference of inadequacy between groups (2.6%). After the adjustment, the inadequacy still remained higher in the control group but the difference between the groups increased to 13.9%.

Through the adjustment, it was possible to observe an increase in the proportion of adequate consumption of
vitamin C in both groups. In the control group, it increased to 9.6%, and in the overweight group to 20.9%. According to Murphy et al., (2006) [22], without the adjustment, the prevalence of inadequacy can be overestimated, considering that the prevalence of consumption below the EAR would be very high, since without the adjustments the distribution of intakes is wider than it should be (because some people ate more than the usual on the day the consumption was reported, and others ate less than normal).

In graphs (1 and 2, 3 and 4), it was possible to verify a decrease in consumption distribution with the settings of intra-personal variance. In a study by Slater (2004) [1], conducted with 79 adolescents aiming to achieve the intrapersonal adjustment for consumption of phosphorus, an increase in the adequacy was not observed, but an increase of inadequacy to 6%. A decrease in distribution of micronutrients was also found.

These nutritional deficiency studies are important considering that through them, nutritional interventions are planned, for example, flour fortification with iron and folic acid and salt fortification with iodine (MORIMOTO et al., 2006) [15]. But if the prevalence of inadequacy is overestimated or underestimated, the nutritional intervention will be erroneously done.

Although this approach helps to reduce bias, the main objective to be achieved by any nutritionist during the evaluation of the nutrition survey[1,14-15,22], some considerations and limitations should be made about this method.

This method requires the requirement (EAR) distribution to be symmetrical and that the variance of consumption is greater than the variance of necessity. However, the micronutrient iron has a skewed requirement distribution, therefore, the prevalence of iron inadequacy cannot be estimated by this method [1, 22].

If the studied group is small and the usual intake is measured only in a few days, perhaps the intrapersonal adjustment is not as accurate. If it is possible to obtain the feeding data in only one day of intake, variation intake data might be symmetrical and that the variance of consumption is estimated by this method [1, 2, 4, 6].

In this study, the goal was not to discuss why the adequacy of vitamin C was higher in the overweight group, however the orange was the third most consumed fruit in this group (remaining below the banana and the apple). In the control group the apple, banana and watermelon were the most consumed fruits[23].

6. CONCLUSION

The removal of the person variance presented itself as an important factor in the evaluation of food consumption, but there must be a critical judgment in the use of this methodology, since it may not be feasible to all samples and micronutrients.

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REFERENCES


