Adequacy of Intake of Nutrients among Shift Workers in a Public Hospital of Rio de Janeiro, Brazil

Odaleia Barbosa de Aguiar1, Eliane de Abreu Soares2, Camila Fidelis Nobre3, Lúcia Rotenberg4, Rosane Härter Griep4 and Maria de Jesus M. da Fonseca5

1Department of Applied Nutrition, Rio de Janeiro State University, Brazil
2Department of Basic and Experimental Nutrition, Rio de Janeiro State University, Brazil
3Postgraduate program in Food, Nutrition and Health, Rio de Janeiro State University, Brazil
4Environment and Health Education Laboratory, Oswaldo Cruz Institute (Fiocruz), Brazil
5Department of Epidemiology and Quantitative Methods in Health, Oswaldo Cruz Foundation, Brazil

Correspondence should be addressed to odaleiab@hotmail.com

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Abstract The analysis of nutrient intakes of shift workers has shown a diet low in fiber and high in animal protein, saturated fatty acids, and high energy foods. This study aimed to analyze the adequacy of nutrient intakes according to the work shifts among nursing professionals of a public hospital in Rio de Janeiro. We interviewed 307 workers and collected data on socioeconomic conditions, work, physical activity, nutritional status and food consumption according to two 24-hour dietary recall (24-hour). Adequacy of nutrients was based on the Dietary Reference Intake. To compare the means of nutrient adequacy we used the Student's t-test, and the Qui-Square was used to compare the proportions (p <0.05). The average energy and macronutrients intake was adequate in relation to the recommendations, except for proteins, which presented above intake. As for other dietary components, adequate intake was only found for iron among men and vitamin C among women. The workers presented dietary inadequacy of micronutrients regardless of the work shift. Thus, incentives for healthy eating are needed by these professionals, in order to increase access to food sources of micronutrients.

Keywords Micronutrients; Macronutrients; Nurse Team; Food Intake

1. Introduction

In shift work, teams of workers take turns so as to allow the availability of the service or production for a longer interval than daily workdays (Fischer et al., 2013). This type of work organization includes activities performed outside the so-called usual hours (from 8 or 9 a.m. to 5 p.m. or 6 p.m. on weekdays), including those performed at night and at weekends. Among the modalities of shift work are alternating shifts (working at different times according to predetermined scale) and fixed shifts, i.e. always at the same time (Fischer et al., 2013). One of the sectors that most employ shift workers are hospitals, given the need to provide uninterrupted care throughout the 24 hours (Dall'Ora et al., 2016).
In Brazil, hospital nursing teams generally work on fixed 12-hour day-shift or night-time shifts - followed by 36 or 60 hours off (Silva et al., 2011).

Shift work, especially night work, implies the need to stay active at night and rest during the day, which leads to consequences for sleep quality and duration (Boivin and Boudreau, 2014). Sleep deprivation, in turn, affects the consumption of snacks, increasing the preference for densely energetic foods (Chaput, 2014). Sleep deprivation coupled with circadian maladjustment due to night work leads to cardiovascular (Esquirol et al., 2011) and metabolic disorders such as diabetes mellitus (Hansen et al., 2016) and metabolic syndrome (Kawabe et al., 2014). In addition, several studies point to changes in lifestyle among night workers, with higher prevalence of those who are not physically active, smokers and obese (Puttonen et al., 2010).

Although literature as a whole points to the deleterious effects of shift work to health, especially night work, few studies consider the adequacy of the diet of nursing professionals, suggesting that they present changes in eating habits. Some authors hypothesize that these workers have a high-carbohydrate diet, fats and caffeine; lower intake of dietary fibers and in some cases an increase in alcohol consumption (Assis et al., 2003; Lowden et al., 2010). However, a recent study did not detect differences between day and shift workers (different schemes) regarding diet quality, although presented higher energy consumption, which would partially explain the higher prevalence of overweight and obesity in this group (Hulsegge et al., 2016).

Inadequate eating habits can produce short-term effects, which are related to energy supply, or long-term effects related to deficiency of intake of essential nutrients, i.e. vitamins, minerals, amino acids and essential fatty acids that are necessary for the functioning of the organism.

The contingent of shift workers has expanded in several countries (Sangheon et al., 2009; Costa, 2010), which demands attention from companies, institutions and the academic community regarding the specificities of this population in relation to health, including aspects related to the quality of food. Thus, this study aimed to analyze the adequacy of nutrient intake in the day and night shifts, according to sex and age of nursing professionals in a public hospital in Rio de Janeiro.

2. Materials and Methods

Population and Sample

The study was carried out with the nursing team (nurses, nursing technicians and aids) of a public hospital in Rio de Janeiro. The population of 1,369 professionals was considered, using a conservative prevalence of 50%, with 95% confidence and 5% of error. The sample calculation estimated the accomplishment of 330. Participated 307 workers, considering 14 (4.2%) losses due to refusals; nine (2.7%) exclusions due to energy intake of less than 500 kilocalories.

Data Collection

The collection was performed in the work environment, in a room assigned by the nursing head. Two 24-hour dietary recall (24 hour) were applied by previously trained interviewers from the nutrition area, to workers who had agreed to participate in the study and had signed the informed consent form. The first recall was applied considering the day the worker was in the work environment and the second, on the day after the day off, on non-consecutive days.

Participants reported all food and beverages consumed in the 24 hours preceding the interview and photographic album of food portions was also used to enhance the accuracy and the record of food items consumed. The participants informed the time, place, amount consumed in household measures, the way of preparation, and in the case of industrialized products brands were also
informed. When it was not possible to fulfill the 24 hour, this was done by telephone, totaling 10 people in the sample (4%). The workers also participated in an interview to fill out a questionnaire with thematic blocks related to socioeconomic, occupational, health status and lifestyle data.

**Description of Variables**

The socioeconomic and lifestyle characteristics considered in this study were: age, sex, schooling and physical activity. According to FNB / IOM / DRI recommendations (2005), age was stratified into intervals: 19 years to 30 years; 31 years to 50 years; 51 years to 70 years. Schooling was categorized in complete elementary education, complete secondary education and complete graduation. The level of physical activity (LPA) was based on the International Physical Activity Questionnaire (IPAQ) (Craig et al., 2003).

The definition of working hours was based on the question "Do you work regularly (at least once a week / 4 times a month) on night shifts in nursing care somewhere?" Workers who answered "Yes" were classified as working night; the others were categorized working day shifts. It should be noted that this classification considers all workplaces, not necessarily the working hours in the study hospital. So, day workers work exclusively during the day at the study hospital or elsewhere. On the other hand, the group of night workers can include professionals who work during the day, besides taking night shifts.

Body mass and height were measured to determine the Body Mass Index (BMI). The classification followed the criteria recommended by the WHO (1998) for adults and Lipschitz et al. (1994) for adults aged 60 years or older.

To analyze 24 hour household measurements were converted to gram (g) and milliliter (ml) based on the Table for Food Consumption in Household Measurements (Tabela para Avaliação de Consumo Alimentar em Medidas Caseiras, (2002) - TACAMC). Food preparations and processed products not included in the TACAMC were searched on recipes websites. The ingredients of the culinary preparations were separated for analysis of the nutritional composition.

The nutritional composition of the diets was analyzed using the Brazilian Table of Food Composition (Tabela Brasileira de Composição de Alimentos. (2011) - TACO). In order to make food intake reliable, soybean oil (4 ml) and salt (1 g) were added to 100 grams of the following preparations: rice, beans, pasta, red meat, fish, eggs and chicken (Food and Nutrition Board, 2000). This increase is justified by the lack of addition of oil and salt in the preparations analyzed in the TACO (2011). In addition, nutritional information of industrialized foods labels, which were not included in the table, was added.

To investigate energy adequacy, the Estimated Energy Requirements (EER) was determined through the equation that, besides taking into account sex, height, age and physical activity level, also considers individuals with adequate weight, overweight or obesity (FNB/IOM/DRI, 2005).

The adequacy of macronutrients and micronutrients, were evaluated according to the recommendations of Dietary References Intakes (FNB/IOM/DRI, 2005) were used. Macronutrients were used for the Accelerated Macronutrient Distribution Range (AMDR), and for calcium, iron and vitamin C were used the Estimated Average Requirement (EAR) (FNB/IOM/DRI, 2011; 2002; 2000). Adequate Intake (AI) was used for dietary fiber and sodium (FNB/IOM/DRI, 2005; 2004). The assessment of micronutrient adequacy was estimated by means of a statistical approach called ‘apparent adequacy’, which allows to estimate the degree of confidence that the intake of a given nutrient reaches the nutritional needs of an individual. This approach compares the difference between the reported intake and EAR values. For nutrients that have not established the EAR, AI reference values were used (Marchioni et al., 2004).
The Z-score calculation of the nutrient apparent adequacy is based on EAR and AI values (FNB/IOM/DRI, 2004). In order to determine the apparent adequacy of nutrients it is necessary to take into account the variation of the nutrient need, the variability of intrapersonal consumption, the intake estimation and the estimated average need for EAR values. The estimation of intrapersonal consumption variability allows us to explain the variation in daily food consumption, which is given by the nutrient's coefficient of variation (CV), which in the present study was 10% (FNB/IOM/DRI, 2000a). Values of American intrapersonal variability was used (Marchioni et al., 2004; FNB/IOM/DRI, 2000a), since in Brazil population-based data on this variability are not available.

The result estimates the adequacy of the diet, that is, the degree of confidence with which the individual's intake reaches the nutritional needs, considering adequate the results that obtain Z-score greater than zero. In cases where the AI recommendation was used, the individual's usual intake was quantitatively classified as above or below recommendations (FNB/IOM/DRI, 2000a).

### Statistical Analysis

In the simple descriptive analyzes, the t-test compared the means, considering the level of significance of 5%. For the proportions, the Chi-Square Test ($\chi^2$) and Fisher's Exact Test ($p = 5\%$) were used. Data were analyzed in the statistical software RStudio, version 3.2.1.

### Ethical Aspects

The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Research Ethics Committees of Fiocruz (635/11) and of the hospital where the study was conducted (000.472).

### 3. Results

Higher rates of daytime workers were observed among married women with a nurse position. Among the night workers, the highest were observed among single men with family income above US $2,288.73 and obese (Table 1).

#### Table 1: Socioeconomic, labor and health characteristics of nursing professionals, according to work shifts

<table>
<thead>
<tr>
<th>Variables</th>
<th>Day Shift</th>
<th>Night Shift</th>
<th>p - value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>16 (39.0)</td>
<td>25 (61.0)</td>
<td>0.06</td>
</tr>
<tr>
<td>Female</td>
<td>149 (56.0)</td>
<td>117 (44.0)</td>
<td></td>
</tr>
<tr>
<td>Age group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19-30 years</td>
<td>28 (60.6)</td>
<td>27 (39.4)</td>
<td>0.20</td>
</tr>
<tr>
<td>31-50 years</td>
<td>71 (50.9)</td>
<td>72 (49.1)</td>
<td></td>
</tr>
<tr>
<td>51-70 years</td>
<td>66 (60.6)</td>
<td>43 (39.4)</td>
<td></td>
</tr>
<tr>
<td>Schooling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elementary School</td>
<td>08 (66.7)</td>
<td>04 (33.3)</td>
<td>0.61*</td>
</tr>
<tr>
<td>Complete High School</td>
<td>59 (54.6)</td>
<td>49 (45.4)</td>
<td></td>
</tr>
<tr>
<td>Complete Graduation</td>
<td>98 (52.4)</td>
<td>89 (47.6)</td>
<td></td>
</tr>
<tr>
<td>Marital Status</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>107 (56.6)</td>
<td>82 (43.2)</td>
<td>0.08</td>
</tr>
<tr>
<td>Separate / Divorced</td>
<td>28 (59.6)</td>
<td>19 (40.4)</td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>30 (42.3)</td>
<td>41 (57.7)</td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Inadequate food intake was identified in the various age groups and in both shifts for calcium, sodium and dietary fiber for male and female. As for iron, adequate consumption was found in all age groups and work shifts among men. Vitamin C was adequate only among men aged 31 to 50 years and 51 to 70 years in the night shift. Among women, iron intake was adequate in all age groups of the night shifts and only 51 to 70 years in the day shift; and for vitamin C, only the age range of 31 to 50 years was inadequate (Table 2).

Table 2: Average consumption of micronutrients and dietary fiber of nursing professionals in relation to reference values (FNB / IOM / DRI), by sex, age group and work shifts

<table>
<thead>
<tr>
<th>Position</th>
<th>Male</th>
<th>Female</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nurse</td>
<td>60 (59.4)</td>
<td>63 (57.8)</td>
</tr>
<tr>
<td>Technician</td>
<td>25 (46.3)</td>
<td>59 (55.1)</td>
</tr>
<tr>
<td>Auxiliary</td>
<td>80 (52.6)</td>
<td>80 (52.6)</td>
</tr>
</tbody>
</table>

BMI
- Eutrophic: 63 (57.8); 62 (57.8)
- Overweight: 59 (55.1); 58 (58.8)
- Obesity: 41 (46.1); 40 (40.0)

Inadequate food intake was identified in the various age groups and in both shifts for calcium, sodium, and dietary fiber for male and female. As for iron, adequate consumption was found in all age groups and work shifts among men. Vitamin C was adequate only among men aged 31 to 50 years and 51 to 70 years in the night shift. Among women, iron intake was adequate in all age groups of the night shifts and only 51 to 70 years in the day shift; and for vitamin C, only the age range of 31 to 50 years was inadequate (Table 2).

The average of the EER of the day shift nursing professionals was 2,163 kcal and the energy intake 1,692 kcal. In the night shift the EER was 2,248 kcal and the energy intake 1,674 kcal. In both shifts
the EER value was not reached, and we observed significant differences (p < 0.001) between day and night shifts.

Table 3 shows the distribution of the macronutrient percentage of the diets ingested by nursing professionals, indicating that the percentage distribution of macronutrients is adequate. However, protein intake per gram / kg weight was higher than the recommendation (FNB/IOM/DRI, 2005).

Table 3: Average consumption of micronutrients and dietary fiber of nursing professionals in relation to reference values (FNB / IOM / DRI), by sex, age group and work shifts

<table>
<thead>
<tr>
<th>Macronutrients</th>
<th>Below n (%)</th>
<th>Adequate n (%)</th>
<th>Above n (%)</th>
<th>Average intake (SD)</th>
<th>Recommendation FNB/IOM/DRI (2005)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHO</td>
<td>53 (32.1)</td>
<td>108 (65.4)</td>
<td>04 (2.5)</td>
<td>49.4% of TEI (8.4)</td>
<td>45% – 65% of TEI</td>
</tr>
<tr>
<td>PTN</td>
<td>21 (12.7)*</td>
<td>---</td>
<td>144 (87.3)</td>
<td>1.15 g/ kg/weight (0.44)</td>
<td>0.66 g/ kg/weight</td>
</tr>
<tr>
<td>LIP</td>
<td>07 (4.2)</td>
<td>105 (63.6)</td>
<td>53 (32.2)</td>
<td>31.3% of TEI (7.0)</td>
<td>20% - 35% of TEI</td>
</tr>
</tbody>
</table>

PTN - Proteins; CHO - Carbohydrates; LIP - Lipids; TEI - Total Energy Intake; * Significant difference between shifts.

Table 4: Analysis of the apparent adequacy of micronutrients of nursing professionals according to sex, age group and work shifts

<table>
<thead>
<tr>
<th>MALE</th>
<th>Age Group (years)</th>
<th>Nutrients</th>
<th>19 to 30</th>
<th>31 to 50</th>
<th>51 to 70</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Day †</td>
<td>Night</td>
<td>Day</td>
<td>Night</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>-</td>
<td>- 0.58</td>
<td>- 0.95</td>
<td>- 1.06</td>
<td>- 1.13</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>-</td>
<td>0.31**</td>
<td>0.55**</td>
<td>0.34**</td>
<td>0.23**</td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>-</td>
<td>- 0.14</td>
<td>0.44**</td>
<td>0.09**</td>
<td>- 0.08</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>-</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FEMALE</th>
<th>Nutrients</th>
<th>19 to 30</th>
<th>31 to 50</th>
<th>51 to 70</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calcium (mg)</td>
<td>- 1.09</td>
<td>- 0.98</td>
<td>- 1.11</td>
<td>- 1.30</td>
</tr>
<tr>
<td>Iron (mg)</td>
<td>- 0.05</td>
<td>- 0.07</td>
<td>- 0.02</td>
<td>- 0.20</td>
</tr>
<tr>
<td>Vitamin C (mg)</td>
<td>0.10**</td>
<td>0.25**</td>
<td>0.00</td>
<td>0.04</td>
</tr>
<tr>
<td>Sodium (mg)</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

**Z Score greater than zero indicates adequacy; † without values † for age group 19-30 years in day shift no male individual was observed.

The apparent adequacy of micronutrients is shown in Table 4. For iron in all age groups and shifts we found adequate intake, and for vitamin C only in the age groups 31-50 years in both shifts for males. The apparent adequacy of sodium was inadequate for men in all age groups and shifts, indicating a higher than recommended intake. As for women, most of the apparent nutrient adequacy results were inadequate, except for iron between the ages of 51-70 years, and vitamin C for the age group between 19-30 and 51-70 years in both shifts.
4. Discussion

For the micronutrient calcium among men and women, in all age group, both the average consumption and the apparent adequacy had the inadequate values in relation to the recommendation. In the literature, in general, results are similar to those found in the present study, i.e., inadequate calcium intake for men and women, even considering ethnic issues, place of residence (urban or rural and food supplementation (Arab et al., 2003; Kolahdooz et al., 2013; Martini et al., 2013). Exception was observed by Viñas et al. (2011), who evaluated data from the European Nutrition and Health Report II (ENHRII) with 12,156 individuals and found suitability for almost all observed nutritional studies, both in men as in women. Calcium is an important nutrient for the maintenance of bone health and its deficiency leads to the onset of osteoporosis, arterial hypertension and consequently poor quality of life.

Both the mean iron intake and the values found by the apparent adequacy method demonstrated that men and women reached the recommendation in all age groups and shifts, except women in the age group of 19-30 years and 31-50 years in the day shift. When comparing the results of mean iron intake with FNB / IOM / DRI (2002), the results are similar to those of apparent adequacy. Manios et al. (2014) in study on 1,468 Greek individuals, observed average iron intake above the recommendation. The findings of Lennernas et al. (1995) on 96 industrial workers on day off and working days in Sweden had values higher than the recommendation. Iron is one of the essential nutrients and its deficiency causes iron deficiency anemia, which is the most prevalent nutritional deficiency in the world.

Comparing the apparent adequacy of vitamin C and FNB / IOM / DRI recommendations (2000), nutrient adequacy was observed for men only for the age group 31-50 years night shift and, for women, adequacy was present in the age groups of 19-30 and 51-70 years in both shifts. In the survey of Arab et al. (2003), in which all 3,548 American women participants presented intake of vitamin C according to the EAR. Manios et al. (2014) found adequate vitamin C for men and women in Greece. Similar result was found by Knutson et al. (1990) with 25 male shift workers from a paper factory. Findings from Kolahdooz et al. (2013) with an African rural population of 136 individuals presented values lower than the recommendation for both sexes. In the study by Nguyen et al. (2014) with 4,983 women in reproductive age in Vietnam, vitamin C was below the recommended levels in all age groups. In the last Brazilian Population Budget Survey - POF 2008-2009 (IBGE, 2010), it was found that the best sources of vitamin C, fruits and vegetables, were consumed less than 10% of the recommendation, a minimum of 400g / day, and this may be a justification for the values of inadequacy found for this vitamin, which is so important to improve the bioavailability of iron.

The mean amount of sodium ingested presented values above the recommendation for men and women in both shifts. Serra-Majém et al. (2007), in a population survey carried out in two different periods in Spain, with samples of 1,211 and 954 individuals aged 10 to 75 years, showed intake above the recommended level. The authors observed that men consumed 3.4 mg less sodium and women increased their consumption by 82.7mg between the periods 1992-1993 and 2002-2003. In the population study with 2,659 individuals, represented by Chinese, Japanese and Americans, Zhang et al. (2015) confirmed values above the recommended level. Chinese men achieved sodium intake from 4,711mg to 7,344mg; the Japanese, from 4,449mg to 4,961mg; and Americans from 3,955mg to 4,346mg. Chinese women consumed between 5,112mg to 6,121mg; Japanese women, 3,701mg to 4,252mg; and American women between 2,791mg and 3,116mg. So it can be affirmed the urgency to implement measures to reduce 30% in the average consumption of salt / sodium of the world population according to the World Health Organization guidelines for the Global Plan of Action for the Prevention and Control of Noncommunicable Diseases (2013), recommending intake less than 2,000 mg sodium / day.
The mean intake of dietary fiber presented values below the recommendation for all age groups, genders and shifts among nursing professionals. In a study conducted in a factory, Knutson et al. (1990) observed inadequate fiber intake in alternating shifts and daytime workers, with consumption of 15.1g / day and 16.6g / day, respectively. However, survey involving South Africans found consumption above the recommendation for men, but women over 19 years of age presented inadequate intake in relation to the recommendation (Kolahdooz et al., 2013). Dietary fibers are among the major dietary component in preventing chronic noncommunicable diseases, having a beneficial power for diverticular disease of the colon, reducing the risk of cancer and controlling diabetes.

The energy consumption of nursing professionals in the two shifts was not adequate for the EER. Studies indicating higher (Kolahdooz et al., 2013) and lower (Nguyen et al., 2014) energy intakes for men, and above (Nguyen et al., 2014) and lower (Araújo et al., 2013) for women are in the literature. In a food survey conducted by Reeves et al. (2004) with 36 nurses from nursing homes and hospitals, the men of the night shift had energy intake of 2,300kcal and those of the day shift 2,211kcal, and were not statistically different. Women presented inversion of the energy intake between the shifts, being smaller in the night shift and greater for the diurnal one, 1,577kcal and 1,669kcal, respectively.

These differences in energy intake among individuals from different countries may be influenced by factors such as: nutritional transition, increased consumption of processed foods, especially ultra-processed foods, by the inadequacy of use equations by populations other than those of origin to estimate the energy value or the food consumption assessment tool used. Most of the time, prediction equations overestimate the basal metabolic rate, causing errors in the estimation of the energy requirement of populations.

The main limitation of this study resides in underreporting of energy intake. That is a well-known and well-documented problem of self-reported dietary assessment methods such as the 24-hour dietary recall. The other limitation of this study is due to the limitation of the Brazilian dietary database. The important strength of this study is in methods and procedures used during the data collection and processing. Precise and comprehensive instructions were given to interviewers for the completion of a single 24-hour dietary recall.

5. Conclusion

Nutritional inadequacies are independent of the work shift among the nursing professionals studied. Incentives for healthy food are needed, so that these professionals will be able to increase access to food sources of micronutrients such as whole grains, fruits and vegetables, milks and dairy products and fish.

Author Contribution

Odaleia Barbosa de Aguiar, Eliane de Abreu Soares, Camila Fidelis Nobre performed the analysis and interpretation of the data and writing of the manuscript. Odaleia Barbosa de Aguiar, Eliane de Abreu Soares, Camila Fidelis Nobre, Lúcia Rotenberg, Rosane Härter Griep and Maria de Jesus M. da Fonseca contributed to the review of the manuscript.

Conflict of Interest

There was no conflict of interest to report.
References


