Nutritional variables and work-related accidents: A case-control study

M.A.T. de Medeiros\textsuperscript{a,}\textsuperscript{*}, Lia Thieme Oikawa Zangirolani\textsuperscript{a}, Ricardo Carlos Cordeiro\textsuperscript{b}, Rossana Pacheco da Costa Proença\textsuperscript{c} and Rosa Wanda Diez-Garcia\textsuperscript{d}

\textsuperscript{a}Department of Public Policies and Collective Health, Institute of Health and Society, Federal University of São Paulo (UNIFESP), Santos, São Paulo, Brazil
\textsuperscript{b}Department of Preventive and Social Medicine, State University of Campinas (UNICAMP), Campinas, Brazil
\textsuperscript{c}Nutrition in Foodservice Research Nucleus (NUPPRE), Department of Nutrition, Federal University of Santa Catarina (UFSC), Florianópolis, Santa Catarina, Brazil
\textsuperscript{d}Nutrition and Metabolism, Department of Internal Medicine, Faculty of Medicine of Ribeirão Preto, University of São Paulo, Ribeirão Preto, São Paulo, Brazil

Received 28 July 2012
Accepted 20 July 2013

Abstract.
BACKGROUND: Nutritional aspects are important for the prevention of diseases and disorders, and few studies have focused on the relationship between risk of work injury and nutritional variables.
OBJECTIVE: This study aimed to verify whether nutritional variables constitute risk factors for work-related accidents.
PARTICIPANTS: 1,422 industrial workers (600 cases plus 822 controls).
METHODS: A case-control study was carried out in an industrial city in south-east Brazil. A multiple logistic regression model was adjusted using work-related accidents as the response variable and nutritional variables as predictors. The associations were assessed by Odds Ratio (OR), with a p-value < 0.05.
RESULTS: 47.29% of the workers were overweight or obese. Protective factors for work-related accidents were (a) attending formal education for an above average number of years (OR = 0.91, p < 0.0001) and (b) eating a traditional dinner (OR = 0.67, p = 0.0087). Risks factors were (a) hard physical effort in the workplace (OR = 1.37, p < 0.0001), (b) having lunch in the workplace (OR = 1.57, p < 0.0001) and (c) receiving government benefits in the form of food stamps (OR = 1.39, p = 0.0350) or food baskets (OR = 1.30, p = 0.0414).
CONCLUSION: Our findings suggest an association between nutritional variables and work-related accidents. This indicates the need, during the formulation of policies for these kinds of government benefits, to include nutrition aspects in order to minimize work-related accidents risks.

Keywords: Work-related accidents, occupational health, nutritional status, nutrition policies, food practices

1. Introduction

Work-related accidents are an important public health concern in Brazil. According to official data, 723,452 occurrences were registered in 2009, which represent a 12.2% increase, compared with the previous year [1].

Concerning the investigation of the causes, researchers focused on risk factors related to socio-economic, demographic, occupational or chemical agent variables [2–5]. Nevertheless, there appears to have been no previous research on the association between work-related accidents and nutritional variables. Investi-
gations into the relationship between dietary habits, lifestyle and the increase in the prevalence of obesity and chronic diseases among workers, have identified the epidemiological factors of obesity [6–12]. In a cohort investigation with Japanese workers, it was found that work overload was positively associated with total energy consumption as well as intake of fiber, vitamins and saturated fat[12].

Work-related accidents can occur due to symptoms of weakness or indisposition, because of nutritional disorders including iron deficiency anemia[13] and other typical signs of hypoglycemia[14]. Thus, addressing workers’ nutritional needs is of utmost importance for the full accomplishment of work tasks.

In Brazil, the recognition of the role of nutritional variables in the prevention of work-related accidents was one of the reasons for the creation of a public policy. This was the Programa de Alimentação do Trabalhador (PAT – Worker Food Program), which allows companies to make tax deductions when investing in employees’ food. This program was established by the Brazilian Ministry of Labor in the 1970s, when extremely high levels of work-related accidents were recorded. Improvements in workers’ health and a reduction in work-related injuries were among the aims of the PAT [15]. This research aimed to investigate whether nutritional variables were associated with work-related accidents.

2. Methods

In 2005, a hospital-based, case-control study was carried out in an industrial city with an estimated population of 318,383, in south-east Brazil [16]. The target population was the economically active population (EAP) of this city, estimated at 138,913 workers; 86,543 and 52,370 of whom were formally and precarious employed, respectively. The following criteria were used for sample calculation: sample size was designed so that a relative risk of 2.0 could be detected; a critical α of 0.05; a β of 0.2 (statistical power of 0.8); a ratio between cases and controls of 1:1. Thus, a minimum of 559 cases and 559 controls were necessary.

Cases were defined as industrial workers aged between 15 and 60 years who had been recently injured in the workplace, resided in this municipality and had sought immediate assistance from the Orthopedics and Traumatology Governmental Centre (OTC) [17]. The participants were those considered clinically able to answer a questionnaire during treatment, and signed, informed consent was provided by all. Two groups of workers were selected as control: (a) non-injured workers, who accompanied the injured workers to be treated, and (b) workers who had been injured but not while performing occupational activities. The members of both groups were aged between 15 and 60, resided in this municipality, and agreed to participate.

The participants were described according to gender, age, socio-economic status, nutritional status and dietary habits. Data on the causes of the occupational accidents were collected for all the cases. Educational status was quantified as complete years of formal education. Occupation type was characterized using questions on shift work (day shift, alternated, night shift, irregular or mixed), working hours, extra hours per week and length in the present job position. The type of employment contract; the workplace (fixed or not), and whether the workers had a formal employment contract or were self-employed, were also investigated.

Participants’ weight and height were used to calculate their Body Mass Index (BMI). Waist circumference was used to estimate the risk of cardiovascular diseases [18]. Information about changes in workers’ body weight during the 12 months prior to the investigation, as well as the level of physical effort in work tasks, were obtained.

Qualitative data on dietary practices were collected, using an instrument developed specifically for this study, to verify whether workers’ diets were structured into regular meals, including the various food groups comprising the standard Brazilian diet [19]. The instrument consisted of asking open and closed questions. Experts evaluated the responses to validate its global quality. After the evaluation, a pilot test was carried out.

The quality of meals was classified using three categories, as follows. (1) Good Dietary Practice: daily intake of fruit/vegetables, rice/beans, dairy products and meat in general; occasional consumption (two or three times a week) of bread and flour derivatives; and rare ingestion (once or less a week) of fried food/snacks, sweets/soft drinks. (2) Reasonable Dietary Practice: daily or occasional consumption of fruit/vegetables, rice/beans, meats and bread and flour derivatives; and rare intake of fried food/snacks, sweets/soft drinks. (3) Bad Dietary Practice: rare intake of fruit/vegetables; daily ingestion of rice/beans, bread and flour derivatives, fried food/snacks, sweets/soft drinks; daily or occasional consumption of meats; occasional or rare consumption of dairy products. Rice and beans were grouped together for assessing the consumption fre-
frequency of these foods, which are typical of the lunch and dinner of the Brazilian population, in the diet of the participants. Other classifications were applied: i) Traditional lunch or traditional dinner: consisting of rice, beans, meat, salad and slide dishes. ii) Fast lunch or fast dinner: sandwich, stuffed pasta (fried or baked), or other kind of fast food. iii) Lunchbox food provided by the company: traditional meal transported in disposable wrapping.

The participants’ dietary patterns were identified using a single variable with two categories: “Individual who had three daily meals (breakfast, lunch and dinner)” and “Individual who had two daily meals (lunch and dinner)”. The consumption of food between meals, during the work shift, was identified as a variable with three categories: “Worker who ate daily between meals”, “Worker who ate occasionally between meals”, and “Worker who ate rarely between meals”. Occasional consumption was defined as two or more times per week (but less than daily), and rare consumption, once or less per week.

Whether the participants received the PAT was also investigated. Companies participating in this program can offer meals in different forms: (i) on-site, produced by the company itself; (ii) on-site, by an outsourced caterer, or (iii) off-site, from an outside supplier. Another alternative is the distribution of food baskets or food stamps for employees to purchase food at selected shops and restaurants [15].

A non-conditional logistic regression model was employed to investigate the association between nutritional variables and work-related accidents. In this model, the dichotomous response variable was the occurrence of a work-related accident (case = 1 and control = 0), whereas the predictor variables were those representing socio-demographic and occupational variables, an assessment of dietary practices, the nutritional status, the time elapsed between meals, BMI, and waist circumference. The presence of an association between these variables was assessed using adjusted Odds Ratio (OR) statistics, with a 95% Confidence Interval (CI).

Univariate logistic regression models were initially adjusted by using nutritional variables as predictors. Dummy variables were created in order to represent the different levels of the categorical variables. After that, multivariate logistic regression models [20] were adjusted by using predictor variables that generated OR estimations with p values lower than, or equal to, 0.25 in the univariate analysis. The adjustments were achieved using the backward method, where a p value less than 0.05 was the maintenance criterion [20]. For adjustment of the multivariate model, the possible confounders of these associations were controlled by considering the following socio-economic and occupational variables: educational status, fixed or changeable workplace, type of work shift, daily working hours, and extra hours worked per week. In view of the small number of women among cases and controls, sex was not included as an independent variable in the final model. For the sake of quality control, data were entered using a double-entry system and then analyzed using the software The SAS® System for Windows, Version 8.

This research was approved by the Research and Ethics Committee of the Faculty of Medicine of Botucatu, Universidade Estadual Júlio de Mesquita Filho – UNESP/Botucatu/Brazil (Process number 445/2004 – CEP).

### 3. Results

The study comprised 1,422 workers: 600 cases and 822 controls, most of whom were male (87.41% of cases and 78.47% of controls), with a mean age of 33 years (Standard Deviation [SD] = 10.41), and attended formal education for an average of 8.39 years (SD = 3.36). Table 1 presents the profile of the participants according to occupational variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cases (%)</th>
<th>Controls (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of contract</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed employment</td>
<td>55.53</td>
<td>62.04</td>
</tr>
<tr>
<td>Formal employment</td>
<td>84.22</td>
<td>80.29</td>
</tr>
<tr>
<td>Typical work contract</td>
<td>86.07</td>
<td>79.80</td>
</tr>
<tr>
<td>Work shift</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed, day shift</td>
<td>90.60</td>
<td>90.63</td>
</tr>
<tr>
<td>Alternated</td>
<td>3.36</td>
<td>2.07</td>
</tr>
<tr>
<td>Mixed</td>
<td>3.35</td>
<td>2.79</td>
</tr>
<tr>
<td>Most frequent occupations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industry worker</td>
<td>59.75</td>
<td>43.14</td>
</tr>
<tr>
<td>Services sector</td>
<td>22.38</td>
<td>26.26</td>
</tr>
<tr>
<td>Physical effort by work tasks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Light</td>
<td>20.47</td>
<td>25.43</td>
</tr>
<tr>
<td>Average</td>
<td>35.91</td>
<td>42.34</td>
</tr>
<tr>
<td>Hard</td>
<td>43.62</td>
<td>32.24</td>
</tr>
</tbody>
</table>

Table 1: Occupational variables of workers included in the case-control study (n = 1422), Piracicaba/SP, Brazil, 2005.
Table 2
Nutritional and dietary features of workers included in the case-control study (n = 1422), Piracicaba/SP, Brazil, 2005

<table>
<thead>
<tr>
<th>Variable</th>
<th>Cases (%)</th>
<th>Controls (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutritional status</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low weight</td>
<td>3.85</td>
<td>4.14</td>
</tr>
<tr>
<td>Normal weight</td>
<td>50.00</td>
<td>47.45</td>
</tr>
<tr>
<td>Overweight</td>
<td>28.26</td>
<td>27.62</td>
</tr>
<tr>
<td>Obesity I</td>
<td>13.54</td>
<td>15.94</td>
</tr>
<tr>
<td>Obesity II</td>
<td>4.35</td>
<td>4.87</td>
</tr>
<tr>
<td>Cardiovascular risk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Moderate</td>
<td>16.39</td>
<td>18.25</td>
</tr>
<tr>
<td>High</td>
<td>13.04</td>
<td>17.64</td>
</tr>
<tr>
<td>Weight gain during the previous 12 months</td>
<td>59.43</td>
<td>61.46</td>
</tr>
<tr>
<td>Included in the PAT*</td>
<td>85.33</td>
<td>82.36</td>
</tr>
<tr>
<td>Type of food benefit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Employer-based restaurant or canteen</td>
<td>23.63</td>
<td>26.55</td>
</tr>
<tr>
<td>Outsourced restaurant or canteen</td>
<td>13.48</td>
<td>13.01</td>
</tr>
<tr>
<td>Food stamp</td>
<td>21.48</td>
<td>19.56</td>
</tr>
<tr>
<td>Food baskets</td>
<td>37.30</td>
<td>33.43</td>
</tr>
<tr>
<td>Others</td>
<td>1.57</td>
<td>1.24</td>
</tr>
<tr>
<td>No information</td>
<td>2.54</td>
<td>6.21</td>
</tr>
</tbody>
</table>

The most common immediate causes of work-related accidents were machinery and equipment (23.67%), falling objects (23.67%), excessive effort or load (13.00%), and falls (8.63%), resulting in contusion (46.67%), torsion (14.83%), contusion-cut wounds (10.33%) and fractures (9.00%). The most common areas of the body injured were hands (36.50%), feet (18.50%), upper limbs (14.67%), lower limbs (14.00%), and back (9.33%).

Table 2 lists issues related to the nutritional status and participation in the PAT. The high prevalence of overweight/obese individuals among cases and controls is noteworthy. Referring to the PAT, 37.30% of cases and 33.43% of controls received food baskets.

Tables 3 and 4 summarize the OR estimations achieved by univariate logistic regression. Variables associated with occupational accidents with p values < 0.25, are highlighted.

Table 5 displays the OR and CI estimations obtained by the multivariate logistic regression model, adjusted from variables that had p values < 0.25 in the univariate analysis, and controlled according to socioeconomic and occupational variables. Analysis of the regression residuals gave no evidence of violations of the variables assumed in the logistic model. There was no indication of interaction or confounding between the selected variables.

The socio-economic, occupational and lifestyle variables that maintained an association with work-related accidents were (1) alternating or mixed-work shifts, (2) work requiring hard physical effort and (3) smoking habitually. The nutritional variables associated with an increased risk of work-related accidents were (1) having lunch in the workplace and (2) receiving benefits in the modality of food stamps or food baskets. Eating a traditional dinner was associated with a lower risk of work-related accidents.

4. Discussion

With respect to the socio-economic variables, workers with a higher number of years of formal education were at lower risk of work-related accidents (OR...
The chances of accidents were higher for individuals working mixed (OR = 2.07, CI = 1.11–3.86) and alternating shifts (OR = 1.99, CI = 1.01–3.93). This corroborates the already documented studies about the role of changing workplaces with the aim of facilitating the adaptation of the worker’s body, to reduce internal desynchronization, in order to prevent accidents [9, 21, 22]. Work tasks demanding hard physical effort increased the probability of accidents (OR = 1.37, CI = 1.08–1.73). These findings concur with those of Lima et al. [2], who analyzed workload and concluded that intense physical effort elevates the chances of work accidents.

Population-based surveys indicate a deterioration of dietary patterns in Brazil over the last three decades, especially with an increased consumption of processed foods. The growth in the number of people in the workforce, who are overweight/obese and have comorbidities, confirms the trend that this deterioration in food patterns contributes to weight gain and its comorbidities [23].

In the present study, eating a traditional dinner, instead of a fast-food meal, remained a protective factor for workplace accidents. This seems reasonable, since health improvement depends, among other factors, on a good nutritional status [23, 24]. However, the finding that having lunch at work increased the chances of accidents (OR = 1.57, CI = 1.25 to 1.98) was not a conclusion supported by literature. In another study with this same population [17], it was found that most of the injured workers consumed three meals a day (62.50%) and 24.16% missed breakfast. One can hypothesize that workers going for a long period of time without food, consequently overate at lunch and had postprandial drowsiness, increasing the risks of having an accident [25, 26]. Eating lunch at work plus an increased chance of having an accident

= 0.91, CI = 0.88–0.95). This is possibly because the higher educational status of these employees enables them to perform jobs with lower risks, e.g. management positions, which have less exposure to high physical work demand [2]. The chances of accidents were
could possibly be explained by a lack of time for adequate rest after this meal and before the resumption of work activities. It might also be suggested that the nutritional quality of lunch would not be appropriate, containing excessive calories derived primarily from fats and simple carbohydrates, as shown by the Brazilian studies on the nutrition of workers [23,27–29].

Concerning the Worker Food Program, findings suggested that workers who received food stamps (OR = 1.39, CI = 1.02–1.89) and food baskets (OR = 1.30, CI = 1.01–1.68) were at higher risk of work-related accidents. These types of benefits could favor bad dietary practices since current research points to a trend for adult Brazilians to choose highly processed food [23, 30]. However, this result should be viewed with caution, as the scientific literature does not include data to support the hypothesis that these types of benefits are related to work-related accidents. Nonetheless, studies have shown a higher prevalence of work limitations in workers who are obese, compared with those of normal weight. In addition, research showed that being overweight or obese can be co-risk factors for the development of occupational asthma, cardiovascular disease, and further modifying the response of workers to occupational stress [6,7,10].

Nevertheless, the present finding should promote a discussion about the need for rethinking the types of benefits given to employees, in order to prioritize the consumption of food ‘in natura’ and reduce the amount of processed food in workers’ diets. Two points for this discussion are suggested by this study. The first is the need to improve the quality in the composition of the food baskets provided to workers, respecting the cultural diversity and regional of Brazil. The second is the need to implement strategies to promote healthy eating in the workplace, with a view to personal autonomy for the choice of high-quality food, to use food stamps.

The target population of food benefits is workers from the formal economy sector, mainly those from Brazil’s more industrialized regions. The coverage of PAT is 9,329,234 employees, of which 17.08% are beneficiaries of food baskets and 47.9% by food stamps [17]. These modalities are the most difficult to assess, since there is a great network of food shops engaged in the distribution of meals or other food, and it is difficult to determine workers’ food choices [31].

Veloso et al. [28] evaluated the impact of PAT on weight-gain and concluded that, 30 years after implementation, instead of workers being nutritionally deficient as before, they had become overweight, and this weight gain was higher, compared with those not covered by PAT. It is worth noting that the present study detected a high percentage of weight gain among cases (59.43%) and controls (61.46%) and that the majority of workers receiving PAT reported weight gain over the year previous to the investigation.

A research was carried out on the relationship between nutritional status and the receipt of benefits in the form of food stamps or food baskets, with beneficiaries of the PAT programs from the south-east and north-east regions of Brazil. This study verified that these forms of food support were the most accessible to overweight workers, including those with lower incomes [32]. Other studies of workers have identified the inadequate quality of the meals consumed by beneficiaries of this government program [27–29,33].

In this study, relevant aspects of dietary practice maintained an association with a risk of work-related accidents in a logistical regression model, which is why these findings should prompt further investigations. There are some limitations to these findings because to date, there have been no reports on the relationship between risk of work injury and nutritional variables, which makes it difficult to compare results with other studies. In addition, there is a complex causal network involving work-related accidents, concerning not only nutrition levels but workers’ job factors and the working environment, which may be associated with their education level or job contract status. On the contrary, this innovative work calls for additional research in order to increase knowledge about the connection between nutritional practices and work-related injuries. It also points to the need for intersectoral investigations to include areas such as health, work and food and nutritional security, to improve the feeding policies of Brazilian workers.

5. Conclusion

This study aimed to investigate the association between nutritional variables and work-related accidents. The main results suggest that receiving PAT benefits in the form of food stamps or food baskets are risk factors, and eating a traditional dinner is a lower risk factor. These findings reinforce the need for intensified surveillance programs, aiming to minimize the exposure of the beneficiaries to nutritional disorders and to work-related accidents.
References


