EVALUATION OF MICROCOMPUTER NUTRITIONAL TEACHING GAMES IN 1,876 CHILDREN AT SCHOOL


SUMMARY - Objective: We evaluated in a prospective study microcomputer nutritional teaching games and their contribution to the children’s acquisition of nutritional knowledge and improvement of eating habits.

Material and methods: One thousand eight hundred seventy-six children aged 7-12 years took part in this study at school. All 16 schools of the same school district were randomized into two groups: games group and control group, both receiving conventional nutritional teaching by their teachers. The children in the games group played computer games during the conventional nutritional teaching period (2 hours a week for 5 weeks). At completion of the study, dietetic knowledge and dietary records were evaluated in both groups.

Results: Dietary knowledge tests results were better in the games group (p < 0.001). The children in the games group had a significantly better balanced diet for an energy intake of about 1900 kilocalories: more carbohydrate (46.4 ± 0.2% vs 45.7 ± 0.2%, p < 0.05), less fat (37.1 ± 0.1% vs 37.6 ± 0.2%, p < 0.05), less protein (16.5 ± 0.1% vs 16.7 ± 0.1%, p < 0.05), less saccharose (11.5 ± 0.1% vs 12.2 ± 0.2%, p < 0.001), more calcium (p < 0.001) and more fiber (p < 0.05). The games group had a better snack at 10 a.m., a less copious lunch and less nibbling (p < 0.001).

Conclusion: The children in the games group had slightly but significantly better nutritional knowledge and dietary intake compared to children in the control group. Using our micro computer nutritional teaching games at school provides an additional and modern support to conventional teaching.

Key-words: nutritional education, microcomputer games, children, school, obesity.

RÉSUMÉ - Evaluation de jeux d’éducation nutritionnelle sur micro-ordinateur par 1 876 enfants à l’école.

Objectif : Nous avons évalué par une étude prospective, l’impact sur les connaissances diététiques et les habitudes alimentaires des enfants, de jeux d’éducation nutritionnelle sur micro-ordinateur.

Materiel et méthodes : Mille huit cent soixante-seize enfants, âgés de 7 à 12 ans, ont pris part à cette étude réalisée à l’école. Les 16 écoles d’une même circonscription académique ont été randomisées en deux groupes : le groupe jeux et le groupe témoin. Les enfants du groupe jeux ont utilisé les jeux durant le temps imparti au cours traditionnel de nutrition (2 heures par semaine pendant 5 semaines). Des tests de connaissances nutritionnelles et des enquêtes alimentaires ont été évalués dans les 2 groupes.

Résultats : Les résultats des tests de connaissances nutritionnelles étaient significativement meilleurs dans le groupe jeux (p < 0.001). Les enfants du groupe jeux présentaient un meilleur équilibre alimentaire à ration calorique égale (1 900 Kcal) : plus de glucides (46.4 ± 0.2 % vs 45.7 ± 0.2 %, p < 0.05), moins de lipides (37.1 ± 0.1 % vs 37.6 ± 0.2 %, p < 0.05), moins de protéines (16.5 ± 0.1 % vs 16.7 ± 0.1 %, p < 0.05), moins de saccharose (11.5 ± 0.1% vs 12.2 ± 0.2 %, p < 0.001), plus de calcium (p < 0.001) et plus de fibres (p < 0.05). La répartition des repas était significativement meilleure dans le groupe jeux avec une collation de 10h plus importante, un déjeuner moins copieux et surtout un grignotage moins important (p < 0.001).

Conclusion : Les enfants du groupe jeux obtenaient donc des résultats légèrement mais significativement meilleurs que les enfants du groupe témoin. L’utilisation de nos jeux d’éducation nutritionnelle sur micro-ordinateur à l’école, apporte une aide moderne et efficace à l’enseignement traditionnel.

Mots-clés : éducation nutritionnelle, jeux sur micro-ordinateur, enfants, école, obésité.

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It is not an easy matter to influence the dietary habits of adults in so far as affective, family related and sociocultural factors play an essential role in nutritional behavior. It seems that children gain greater advantages from nutritional education than adults [1, 2]. The goal in this form of training is the prevention of nutrition-related diseases like obesity, diabetes and atherosclerosis whose prevalence is constantly increasing in the industrialized countries [3-8]. Early educational initiatives have already been proposed and evaluated. In most countries the best place to implement a major initiative is at school [9-11]. In France education for health is part of the school curriculum, but remains superficial. Our study involved design and evaluation of microcomputer nutritional teaching games with 1876 children in primary schools. This study was intended to evaluate the games and their contribution to the children’s acquisition of nutritional knowledge and improvement of their eating habits by means of questionnaires and diet records.

### SUBJECTS, MATERIALS AND METHODS

#### Subjects

The children taking part in this evaluation were 1876 pupils in the last 3 grades in primary schools in a school district close to a medium-sized city in southwestern France. Their mean age was 9 years (7-12 years old), with 52.5% of girls, 30.9% of children being in 3rd grade primary (7-8 years old), 35.8% in 4th grade primary (9-10 years old), and 33.3% in 5th grade primary (11-12 years old).

The body mass index (BMI) was calculated for 1268 children and compared to French charts [12]. BMI was normal in 76.3% of children, 23.7% were overweight with a BMI above the 90th percentile (25.6% of girls and 21.7% of boys) and 11.1% were obese with a BMI above the 97th percentile (12.1% of girls and 10.0% of boys).

#### Study Design

This prospective study was carried out over the 1996-1997 school year. The 16 schools of the school district took part in this study. These establishments are state schools whose pupils are registered according to their place of residence. Before the beginning of the study, the medical team had discussed nutritional objectives with the teachers (importance of breakfast and snacks, reduction of saccharose and fat intakes, prevention of nibbling). Neither nutritional knowledge, nor eating habits, nor BMI were assessed at baseline. The schools were randomized into two groups: a control group with nutritional teaching provided by the teacher and a games group who had access with their teachers to nutritional learning games on microcomputers. One school in the control group was afterwards unavailable for analysis leaving a total of 15 schools. Time allowed for play (one hour twice a week for 5 weeks, i.e., 10 hours of play overall) was included in conventional teaching periods. So, the time involved in nutritional education was exactly the same for both groups. After 5 weeks, evaluation was carried out in both groups. Some children were absent at different stages of the study, which explains the discrepancies in the number of pupils. After the end of the study, the children of the control group then also had access to the computer games.

#### Evaluation

Evaluation, performed only at the end of the intervention, covered nutritional knowledge, dietary intake and impact on eating habits by means of questionnaires.

The children’s nutritional knowledge was evaluated by a test, performed at school, comprising 8 questions. The answers were scored on a scale from 0 to 10. The questions covered the balance of meals, foods rich in sugar, calcium or fats and the different categories of foods in a way that was accessible to the children (coloring, finding the odd one out, logical associations, etc...).

Dietary intake was studied through a diet record carried out at home, with help from the parents, covering 3 consecutive days including one over the weekend. Children were taught at school how to fill out the diet record by 3 dietitians. The areas covered by the records concerned daily energy intake, analysis of macronutrients, meal distribution and food categories (dairy foods, fruits, etc...) studied as nutritional density (mean weight in grams per day x 1000/total number of kilocalories (Kcal) per day). We analyzed the diet records using our own software based on a cross-checking of several food tables (Renaud, Ciquil, Souci, Roche...).

The impact on eating habits was evaluated through a questionnaire filled out at home with help from the parents based on 9 open questions with 2 main themes: quantitative and qualitative changes in breakfast, snacks and methods of food preparation.

The 3 questionnaires (nutrition knowledge tests, diet records, impact on eating habits) were filled out anonymously and no connection could be easily established between each one. We asked the children to indicate which school they belonged to and their class, and also their sex, age, weight and height.

Dietary intake of obese children was evaluated according to their BMI.
Description of games

**Alimentary my dear Joe (Fig. I)**

This title covers 4 games on CD-ROM developed by a team composed of nutritionists, pediatricians, dietitians and professionals of computer games. These games are aimed at children from 6 years of age onwards, each game having a specific nutritional objective:

The “Store” game teaches children to classify foods according to their categories. The children have to pick up boxes of foods with a crane and store them in the right place.

“Guess who” helps the children to learn what foods contain. Joe gives clues on the food’s personality (composition and nutritional characteristics). A food item is hidden behind a theater curtain which rises when children guess the food correctly.

“Granny Smith” lets the children choose their breakfasts and snacks. Granny Smith usually makes mistakes preparing the list of foods. The children have to find out and correct the mistakes with pencil and eraser.

“The Restaurant” is intended to teach nutritional balance for main meals. In the kitchen, Joe prepares dishes that are to be served in the restaurant. The children have to catch the foods (which are animated in 3D cartoons) which jump out of the refrigerator and put them in the right plate to obtain balanced meals.

In addition to the games, an attractive “calculator” provides the children with a semi-quantitative food table giving symbolized composition of the main foods with their different nutrients.

With each game, the children get a score with a running total being drawn up from game to game until the final score.

The software program runs on a PC compatible with Windows, using a 486 DX2 processor or higher, 8 Mb RAM and a sound card.

**Statistical analysis**

Statistical analysis used t-test and variance analysis (Anova) for quantitative variables and the chi-squared test for qualitative variables. The quantitative data is

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**Fig. 1. Alimentary my dear Joe: a set of 4 microcomputer nutritional teaching games.**
shown as means ± SE. All tests are given with a level of significance of 5%; bilateral.

## RESULTS

### Nutritional knowledge tests (Table I)

The knowledge test was answered by 1 876 children (games n = 1 003; control n = 873). The total score ranged from 0 (no knowledge) to 80 (perfect knowledge). The mean score of the games group was significantly better than the mean score of the control group (48.8 ± 0.4 points vs 46.1 ± 0.4 points) (p < 0.001).

There were significant differences in favor of the games group on questions concerning the nutritional balance of main meals (p < 0.01), the ability to select foods rich in calcium (p < 0.0001) and to identify different categories of foods (p < 0.0001). The difference was at the limit of significance on the question concerning foods rich in fats, always in favor of the games group (p = 0.05). There was a significant difference in favor of the control group on the question concerning foods containing saccharose (p < 0.05). There was no significant difference between the two groups on the question concerning the nutritional balance of breakfast.

### Diet records (Table II)

<table>
<thead>
<tr>
<th>Categories of questions</th>
<th>Games group n = 1003</th>
<th>Control group n = 873</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global tests</td>
<td>48.8 ± 0.4</td>
<td>46.1 ± 0.4</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Breakfast</td>
<td>8.0 ± 0.1</td>
<td>7.9 ± 0.1</td>
<td>NS</td>
</tr>
<tr>
<td>Meal balance</td>
<td>5.5 ± 0.1</td>
<td>5.0 ± 0.1</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Saccharose</td>
<td>5.3 ± 0.2</td>
<td>5.9 ± 0.2</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Calcium</td>
<td>2.0 ± 0.1</td>
<td>0.8 ± 0.1</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Vegetables-starchy foods</td>
<td>7.5 ± 0.1</td>
<td>7.0 ± 0.1</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Vegetables</td>
<td>4.0 ± 0.2</td>
<td>3.5 ± 0.2</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Food categories</td>
<td>8.4 ± 0.1</td>
<td>7.9 ± 0.1</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Fats</td>
<td>8.3 ± 0.1</td>
<td>8.1 ± 0.1</td>
<td>= 0.05</td>
</tr>
</tbody>
</table>

1 Global test (score/80 points).
* Thematic questions (score/10 points).

### Global analysis

The diet record was filled out by 1 576 children (games n = 827; control n = 749).

There was no significant difference in mean daily energy intake between the games group and the control group (1 896 ± 13 kcal vs 1 899 ± 14 kcal, NS), Concerning the distribution of carbohydrate, fat and protein, the children in the games group ingested significantly more carbohydrate than the children in the control group (46.4 ± 0.2% vs 45.7 ± 0.2%, p < 0.05), less fat (37.1 ± 0.1% vs 37.6 ± 0.2%, p < 0.05) and less protein (16.5 ± 0.1% vs 16.7 ± 0.1%, p < 0.05).

The saccharose level was significantly lower in the games group compared with the control group (11.5 ± 0.1% vs 12.2 ± 0.2%, p < 0.001).

The children in the games group ingested significantly more calcium than the children in the control group (771 ± 9 mg vs 731 ± 9 mg, p < 0.001) and more fiber (12.6 ± 0.1 g/l vs 12.1 ± 0.1 g/l, p < 0.05).

Breakfast represented 18.5% of daily calories in both groups. The children in the games group had a higher energy intake in the 10 a.m. snack (6.8 ± 0.2% vs 6.0 ± 0.2%, p < 0.01) and a lower energy intake at lunch (33.1 ± 0.2% vs 34.7 ± 0.3%, p < 0.001) compared with the children in the control group. The games group nibbled significantly less than the control group (5.6 ± 0.3% vs 7.4 ± 0.3%, p < 0.001).

### Table II. Results of diet records.

<table>
<thead>
<tr>
<th></th>
<th>Games group n = 827</th>
<th>Control group n = 749</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories (kcal)</td>
<td>1 896 ± 13</td>
<td>1 899 ± 14</td>
<td>NS</td>
</tr>
<tr>
<td>Carbohydrate</td>
<td>46.4 ± 0.2</td>
<td>45.7 ± 0.2</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Fat</td>
<td>37.1 ± 0.1</td>
<td>37.6 ± 0.2</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Protein</td>
<td>16.5 ± 0.1</td>
<td>16.7 ± 0.1</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Saccharose</td>
<td>11.5 ± 0.1</td>
<td>12.2 ± 0.2</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Calcium (mg)</td>
<td>771 ± 9</td>
<td>731 ± 9</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>Fiber (g)</td>
<td>12.6 ± 0.1</td>
<td>12.1 ± 0.1</td>
<td>&lt; 0.05</td>
</tr>
<tr>
<td>Breakfast</td>
<td>18.3 ± 0.2</td>
<td>18.5 ± 0.2</td>
<td>NS</td>
</tr>
<tr>
<td>10 am. snack</td>
<td>6.8 ± 0.2</td>
<td>6.0 ± 0.2</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Lunch</td>
<td>33.1 ± 0.2</td>
<td>34.7 ± 0.3</td>
<td>&lt; 0.001</td>
</tr>
<tr>
<td>4 pm. snack</td>
<td>13.5 ± 0.2</td>
<td>12.9 ± 0.3</td>
<td>NS</td>
</tr>
<tr>
<td>Dinner</td>
<td>31.2 ± 0.3</td>
<td>30.6 ± 0.3</td>
<td>NS</td>
</tr>
<tr>
<td>Nibbling</td>
<td>5.6 ± 0.3</td>
<td>7.4 ± 0.3</td>
<td>&lt; 0.001</td>
</tr>
</tbody>
</table>

¹ Nutrient calories/total calories without alcohol (%).
* Meal calories/total calories (%).
The categories of foods eaten were studied as food density. The games group ate more plain dairy products (p < 0.05) and more starchy food (p < 0.001), less meat (p < 0.005), less delicatessen food (p < 0.01), less sweetened dairy dessert like ice cream (p < 0.0001) and less fat (p < 0.0001). The children in the games group ate less green vegetables (p < 0.0001) but more fruits (p < 0.0001).

**Diet record results according to BMI**

The body mass index (BMI) was calculated for 1268 children. Three groups were defined according to French charts [12]: children with a normal BMI (group 1, n = 967), overweight children with a BMI above the 90th percentile (group 2, n = 160) and obese children with a BMI above the 97th percentile (group 3, n = 141).

Whatever the group (games or control), there was no significant difference in diet between children in group 1 and those in group 2. Group 3 had a significantly lower energy intake than group 2 and group 1 (1 806 ± 33 kcal vs 1 950 ± 27 kcal vs 1 915 ± 12 kcal, p < 0.005) and a lower saccharose intake (11.0 ± 0.3% vs 12.0 ± 0.3% vs 12.1 ± 0.1% saccharose/total kcal, p < 0.05). Nevertheless, group 3 ate significantly more at lunch (35.6 ± 0.6% vs 33.6 ± 0.5% vs 33.5 ± 0.2% kcal lunch/total kcal, p < 0.005) and skipped breakfast more often, at least once during the three days of diet records (13.5% of children vs 6.2% vs 6.1%, p < 0.005).

Obese children in the games group (n = 75) tended to have a better balanced diet than the control group (n = 66) with more carbohydrate (46.6 ± 0.2% vs 44.9 ± 0.8%) and less fat (36.9 ± 0.5% vs 38.2 ± 0.5) although the difference did not reach significance. They also ate significantly more during snacks (7.0 ± 0.7% vs 4.9 ± 0.8%, p < 0.05) and less at lunch (34.1 ± 0.8% vs 37.1 ± 0.9%, p < 0.05) than the control group.

**Impact on eating habits**

The questionnaire on dietary habits was answered at home by 1566 children, helped by their families (games group n = 846, control group n = 720). In the games group 22.8% of the children said they had changed their snacks versus 17.8% of the children in the control group (p < 0.05). 80.4% of the children in the games group said they ate fruits and vegetables every day versus 76.1% of the children in the control group (p < 0.05).

### DISCUSSION

This study shows firstly that these games are suitable for use in schools and secondly that they appear to improve nutritional education. The children very much enjoyed the nutritional teaching games. Their teachers greatly appreciated this educational tool and they were prepared to continue and to advise their colleagues to use it. The children in the games group had slightly but significantly better nutritional knowledge and better dietary intake compared to children receiving only conventional teaching. It should be noted that our results, which appear to be moderate, were obtained after only five weeks, with the children playing one hour twice a week. If the games were permanently left available to the schools, we could hope that the children would draw additional benefit from repeated information. This may represent a first step towards better eating habits, even if further study would be necessary to show long term results. This study was not carried on for a longer period because, firstly, the children in the control group used the games after the five weeks and so they could no longer be considered as a control group; secondly, many children left primary school at the end of the school year to go to high school. On the other hand, we chose to carry out the evaluation only after the intervention (and not before and after) to avoid parents and children having to fill the questionnaires out twice. We chose to divide the children into games and control groups by randomizing the schools rather than classes, to limit any spill-over effect between children exposed or not to the computer intervention. The constraints of anonymity imposed by the French education system prevented us from linking the various questionnaires to any individual child and thus from studying, in particular, the correlation between knowledge tests and diet records. The difference between the size of the pupil population and the numbers of questionnaires filled out and collected was accounted for by several reasons: some children were absent on the day when the knowledge questionnaires were filled out; some children did not bring back their diet record; lastly one school in the control group was excluded because of a methodology error. This last point also accounts for the fact that the control group was always smaller than the games group.

Regarding results, they were consistent with our objectives: the children in the games group had slightly but significantly better scores for questions concerning main categories of foods and balanced meals, and also, concerning dietary intake, they came closer to nutritional recommendations [13-16] (more carbohydrate, less fat, better distribution of meals and snacks and less nibbling) than the children in the control group. In some points, there was a dissociation between the data of knowledge tests and the diet records. Concerning green vegetables, answers to the knowledge tests were better in the games group while diet records were worse. This may perhaps be explained by the children being unable to completely change the family menu since vegetables generally require more preparation, whereas this obstacle does not exist for fruits whose consumption was greater in...
the games group. Conversely, concerning saccharose, the children in the games group had significantly fewer correct answers in the knowledge questionnaire than the children in the control group; however, they consumed less saccharose than the children in the control group. One possible explanation could be that none of our games was specifically aimed at consumption of saccharose, but the game on breakfasts and snacks systematically excluded very fatty foods and sweet foods like chocolate bars; thus, without knowing exactly the composition of foods, children learnt to make a good practical choice. Concerning food rich in calcium, knowledge was very poor in both groups, perhaps because of the negative impact of television food advertising [17, 18] which exaggerates the calcium content of certain titbits. Moreover, food equivalences and calcium contents were not properly covered by the games and two new games have been designed to achieve these objectives but have not been evaluated.

The games had a significant influence on the dietary intake of children. It is probably at this age, or with even younger children, that nutritional education should be planned at school [19]. The strong incidence of overweight (23.7%) and obese (11.1%) children in the studied population, already observed in a study carried out in 1991 in the same region with a larger series [20], highlights the need for nutritional intervention with young children [21]. These games could also be useful for the education of obese children at home; in this study, indeed, obese children in the games group significantly improved their meal distribution and tended to have a better balanced diet although not significantly so, probably because of the small number of children. If we consider the 141 obese children in the two groups, they had a significantly lower energy intake but which was not properly spread throughout the day.

Comparing the diet of obese children with that of the other children, whatever the group, we found that the obese children had a lower energy intake. This raises several questions: as the obese children have better knowledge of dietetics than the others, did they perhaps cheat in filling out their diet records? Is it because of the bad distribution of their meals during the day? Do they have less physical activity? We have no answer to these questions.

**CONCLUSION**

Nutritional education at school should be a public health objective [2], attempting to prevent nutrition-related diseases in adulthood [8-11]. We showed that using our microcomputer nutritional teaching games at school provides an additional and modern support compared to conventional teaching. In future, we can argue that the development of multimedia communication networks will allow for full-scale development of this type of intervention.

**Acknowledgements** – This study was supported by grants from the French Ministry of Health (Clinical Research Hospital Program).

**REFERENCES**


