To link to this article : DOI : 10.1016/j.jneb.2015.09.011
URL : http://dx.doi.org/10.1016/j.jneb.2015.09.011

To cite this version : Turnin, M.-C. and Buisson, Jean-Christophe and Ahluwalia, Namanjeet and Cazals, Laurent and Bolzonella-Pene, Caroline and Fouquet-Martineau, Caroline and Martini, Pascale and Tauber, Maïté and Hanaire, Hélène *Effect of Nutritional Intervention on Food Choices of French Students in Middle School Cafeterias, Using an Interactive Educational Software Program (Nutri-Advice).* (2016) Journal of Nutrition Education and Behavior, vol. 48 (n° 2). pp. 131-137. ISSN 1499-4046

Effect of Nutritional Intervention on Food Choices of French Students in Middle School Cafeterias, Using an Interactive Educational Software Program (*Nutri-Advice*)

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ABSTRACT

Objective: To evaluate the impact of interactive *Nutri-Advice* kiosks on children's nutritional skills and their ability to apply it to food choices in a middle school cafeteria menu (food choice competencies).

Design: Quasi-experimental design; pre/post-test.

Setting: Freestanding interactive computer terminals (kiosks) were installed in three middle schools in Toulouse, France.

Participants: A total of 580 children were enrolled into the study (mean age, 13 ± 1 years).

Intervention: Each child's physiological profile was stored in a personal barcode card. During 1 school year, once a day, each child could access the kiosk with this card, trying to find the most balanced meal according to his or her profile and the food available on the cafeteria menu.

Main Outcome Measures: Children's food choice competency changes and body mass index *z*-score were evaluated.

Analysis: Significance of change in food choice competencies (postintervention vs baseline) was examined using paired *t* test.

Results: Across the study, children chose significantly less cheese and pastry or desserts, and significantly more starchy food and dairy, and tended to choose fruits and vegetables more often. Body mass index *z*-score decreased significantly during the period.

Conclusions and Implications: Personalized nutrition counseling through an interactive device has the potential to improve the food choice competencies of children.

Key Words: nutrition education, middle school, interactive kiosk, food choices, cafeteria

Accepted September 22, 2015. Published online November 6, 2015.

INTRODUCTION

Obesity in developed countries has become a major health issue[1] that necessitates setting up specific prevention actions. Children and teenagers would best benefit from such measures, and schools and their cafeterias are perfect places for nutrition education.

In France, public institutions and the Ministry of Health launched the National Plan for Nutrition and Health (PNNS), a succession of strategic plans targeting the general population and health professionals, aiming to improve the health of the population through nutrition interviews. Some of its objectives were related to diet (consumption of fruit and vegetables, and a nutrient balance of calcium, lipids, carbohydrates, and alcohol), and nutritional status (low-density lipoprotein cholesterol, blood pressure, and body mass).[2] The National Plan for Nutrition and Health also includes a specific action aiming to reduce childhood obesity and promotes study-action projects.

The proportion of overweight or obese children and adolescents in France is 19.9% in boys and 16.0% in

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Conflict of Interest Disclosure: The authors' conflict of interest disclosures can be found online with this article on www.jneb.org.
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http://dx.doi.org/10.1016/j.jneb.2015.09.011

girls.[3] Various lifestyle factors such as high caloric intake associated with low physical activity levels lead to increasing prevalence of overweight and obesity.[4,5] In addition, current estimates of the direct economic costs related to obesity in the European Union are around 2% to 8% of total health expenditure.[6]

Few studies assessing the efficacy of point-of-service interactive media on teenagers' eating behavior have been published to date.[7-9] The software program *Nutri-Advice* was designed in the Diabetology and Nutrition Department of Toulouse University Hospital, using a game format to encourage teenagers to make healthful food choices from the lunch menu in the school cafeteria.

This article reports the setup of the kiosks and their ability to improve children's nutritional understanding. This uncontrolled study aimed to assess the ability of the *Nutri-Advice* kiosk to improve children's nutritional skills, with the devices being used in schools as standalone and free-access innovative educational tools.

METHODS

Sample

The researchers conducted the study after obtaining permission from the Division of School Health of the Toulouse Academy (Ministry of Education) in southwest France. The project was submitted and approved by the Ethical Committee for Biomedical Research, Toulouse, France, and the National Committee for Information and Liberty.

The Academy of Toulouse selected 3 middle schools that met the following criteria: they were located in the Toulouse area and were representative of suburban (school A) and urban populations (schools B and C), and schools were equipped with a kitchen (ie, cafeteria meals were cooked onsite) that offered the children several choices of foods at lunch. The nature of the study and the implications for the school staff (administrators, teachers, and kitchen chef) were explained at meetings in each school and the 3 schools agreed to comply with the study protocol.

Interactive Computer Software Development

The *Nutri-Advice* software was based on an existing program (Nutri-Expert, University Hospital of Toulouse, Toulouse, France, 2000).[10] The software was modified to target school-aged children, to be run on standalone interactive computer stations, and to improve nutritional skills through examples based on the food available for lunch at the cafeteria. *Nutri-Advice* software was available on multimedia kiosks consisting of a computer, a touch screen, and a bar code scanner. It adjusted for gender, age, anthropometric data (height and weight), and the physical activity profile of children to calculate their caloric needs.[11,12] It considered the number of meals consumed per day (including snacks) by the child to compute the proportion of energy needs from lunch.

Just before going to the cafeteria, children used the system with their individual identification card; the screen displayed photos of foods proposed for lunch that day at the cafeteria (Figure 1). The child attempted to compose a well-balanced meal, choosing an appetizer (processed meats or salad), a main course (meat or fish, with vegetables and/or starch/beans); 2 desserts (fruit, pastry, ice cream, or milk product), and bread (Figure 2). Children were allowed to skip items or choose half-items (for the main dish or bread). This possibility of modulating portion sizes was important because it allowed children of different ages and genders to make food choices adapted to their energy requirements. Children were not required to eat from the menu they chose on the system, and so their

Figure 1. Child using *Nutri-Advice*. That day, he chose a balanced meal among dishes presented at the cafeteria.

choices might be qualified as virtual, with an educational value.

Considering each child's characteristics, the *Nutri-Advice* program calculated the best choice of dishes from those offered in the cafeteria, accounting for nutrient recommendations.[2] Fuzzy set theory[11,12] was used to model the inherent imprecision of portion weights and food nutritional values, to define more robust norm intervals for energy and relevant nutrients, and to propagate this imprecision through the computations in a mathematically sound way. The system assigned a score (range, 1–10) for the meal chosen by the child and for the best food choice computed by the software. These meal scores were not displayed to the child; they were used for computation purposes only. If the 2 scores were close (the absolute value of their difference is ≤ 2), the child's choice was considered balanced and a congratulatory note was flagged on the screen; if the scores were considered distant from each other, the child's choice was considered not balanced and the software provided general remarks focusing on the areas that required most attention. A meal's score was computed as the weighted mean value of individual compatibility measurements of a set of nutrients and components (carbohydrates, lipids, calcium, fiber, etc) and energy. A nutrient's weighted value in the weighted sum reflected its importance in the general assessment, accounting for the child's characteristics and international nutrient recommendations. Although the investigator team was dealing with teenagers who were growing quickly, they assumed that fixed nutritional assessments remained valid during the 6-month period of the protocol.

On average, each session took less than a minute per child. Each child was allowed to use the kiosk once a day. The system saved the information from each session, so the entire data set could be downloaded at the end of the study for analysis. To keep children motivated, a lottery game was implemented in the device: Children won a point every time they chose a balanced meal. Once a child had earned 7 points, the system automatically ran a lottery game to win a cinema ticket.

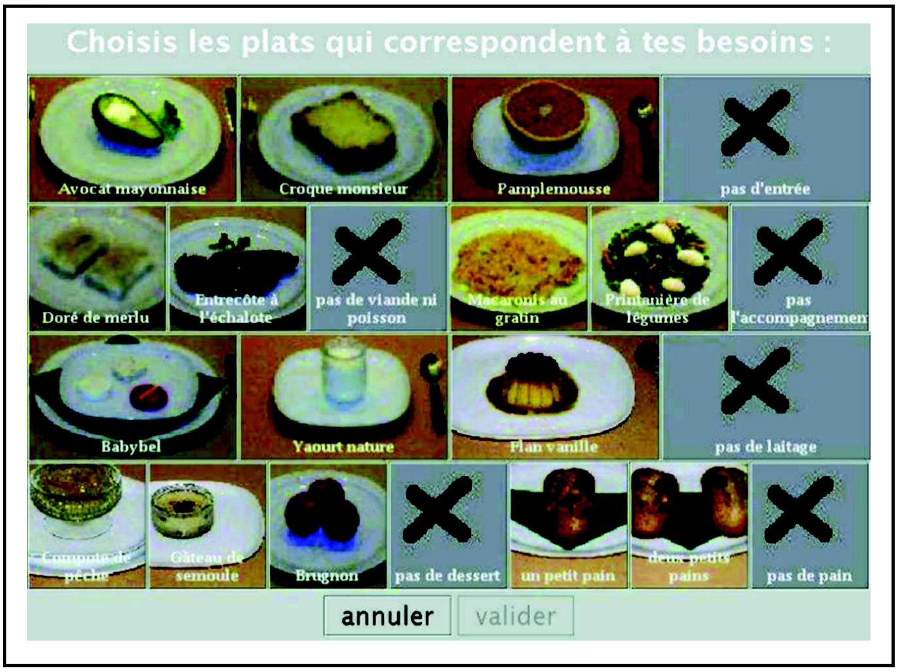

Figure 2. A *Nutri-Advice* screen. The menu item pictures allow the child to assess the quantity. Touching a menu item picture displays several pictures of the item with different quantities.

Project Implementation

Before the beginning of the school year, the dietitians estimated the food composition of all of the recipes offered at lunch in the cafeterias, according to a compilation of several nutrient databases (Ciqual[13] and Souci[14]) and data from ready-to-serve foods. Photos of foods and dishes served at cafeteria lunch were also input into the system.

The study was conducted after the authors obtained permission from the Ethical Committee for Biomedical Research, Toulouse, France, and the National Committee for Information and Liberty. At the beginning of the school year, the study was presented to children in class and an information notice was given to them for their parents, who signed informed consent forms and sent them back to the study team. Parents who desired additional information were able to contact the study team. The study team then went into each school to collect anthropometric measurements at baseline. Self-report information on children's gender and date of birth, the number of meals eaten per day (including snacks), and the physical activity level (at and out of school) were obtained. More specifically, researchers evaluated children-reported physical activities using a comprehensive list of sports and physical activities along with examples assessing their intensity.

The *Nutri-Advice* program was fed by the study team with the self-report information provided by each child; the program computed the caloric needs for lunch and generated a personal computer-based barcode (identification) to be printed on a plastic card to enable the child to be identified by the software.

The kiosks were then installed in each school. The study team delivered the personal bar code cards, demonstrated the use of the *Nutri-Advice* system to children, and explained to the school staff how to enter the menu planned for the following weeks into the computer.

Intervention

The intervention period ran for 6 months, from November until May. *Nutri-Advice* was used in real-life conditions; the device location and how it was accessed was chosen by each school's staff. Children used the software freely once a day, and there was no modification in academic programs related to nutrition practices. The school week ran from Monday to Friday; the children had class approximately from 8 AM to 12 PM and from 2 to 5 PM. Breaks of about 15 min were scheduled around 10 AM and 4 PM, and the 2 hours after noon were devoted to lunch and free time. On Wednesday, classes stopped at noon. Thus, kiosks were switched off on Wednesday. On the whole, the *Nutri-Advice* kiosk was mainly used by children during the morning and noon breaks, and was available 4 days/wk. The overall number of days the *Nutri-Advice* kiosk was available during the intervention period was 72 in school A, 78 in school B, and 67 in school C.

During the study period, technical visits were scheduled as needed to perform computer maintenance and database backup and to observe the environment and use of the kiosks and the quality and matching of menus posted on the kiosks compared with the menu offered that day. Postintervention anthropometric measurements were completed in each school in May.

Measures

The first outcome was a qualitative change in the food choice competencies of children at the end of the intervention compared with those at the beginning. Each record was time stamped and included child and school specific codes followed by a set of variables describing the child's selection and the software computation. After the database had been cleared (first sessions corresponding to staff demonstration, broken or aborted sessions, and post-study sessions dropped), foods chosen for lunch were encoded into 5 groups: dairy products (yogurt or *fromage blanc*), cheese, fruits and vegetables, starch (bread, pasta, rice, potatoes, beans, and lentils), and desserts. For each child, results were expressed as the overall percentage of each food group chosen during the first 3 vs the last 3 connections per child.

Secondary outcomes measured were as follows. Statistics on the frequency of kiosk use were computed using the time-stamped database records described above. Body mass index (BMI) was calculated from pre- and postintervention anthropometric measurements. Body mass index *z*-scores were calculated and obesity was defined as gender- and age-specific BMI above the 97th percentile, according to reference curves for BMI.[15,16]

Statistical Analyses

Stata statistical software (version 10.1, StataCorp, College Station, TX, 2008) was used to perform data analysis. The authors compared pretest and posttest data for each student, which were grouped by school. Results are expressed as means ± SD unless otherwise mentioned. Normality of the distributions was examined for continuous variables with a normal-quantile plot. For variables consistent with the assumption of normality, differences across schools were compared with ANOVA using Scheffé *post hoc* test. For variables that were not normally distributed, differences were compared across schools using Kruskal-Wallis rank test. Chi-square test was used to compare the distribution of qualitative variables between schools. The significance of change in food choice competencies (postintervention vs baseline) was examined using paired *t* test for variables consistent with a normality assumption or Wilcoxon matched-pairs signed-rank test for variables not normally distributed. McNemar test was used to compare distributions of qualitative variables for matched pairs of subjects. The correlation between the change in food choice competencies and number of times the child connected to the *Nutri-Advice* system was examined using Pearson's product-moment correlation. $P < .05$ was considered significant.

RESULTS

A total of 580 children participated in the study: 154 in School A, 207 in school B, and 219 in school C. Mean age was 13.3 ± 1.0 years (range, 11.5–16.4 years) and the schools did not differ in age profiles. Median number of sessions per child was 26 (range, 1–67) during the 6-month period and was significantly higher in school C compared with schools A and B ($P < .001$).

Overall prevalence of obesity was 11.6%, with no significant difference between boys and girls (12.8% and 10.4%, respectively; $P = .38$). Obesity prevalence was significantly different among the 3 schools: 3.9%, 10.1%, and 18.4% in schools A, B, and C, respectively ($P < .001$). Overall *z*-score BMI was 0.50 ± 1.1, and it was different across schools ($P < .009$): The BMI *z*-score in school A was significantly lower than in school C. Most children reported that their physical activity level was moderate; however, children in school C were more active than in school A ($P = .001$).

After the researchers removed incomplete files, data for 350 children were eligible for the final analyses. Table 1 lists the characteristics of the final analysis subgroup and the conditions of kiosk use. The eligible sample (n = 350) was compared with the ineligible sample (n = 230). No differences were found in gender, age, BMI *z*-score, obesity, and physical activity level.

Table 2 shows the change in food choice competencies and weight status over the study period. Among significant findings, children chose dairy products, fruits and vegetables, and starch significantly more at the end of the study compared with baseline, whereas the choices of dessert and of cheese at lunch were significantly reduced over the study period. These effects varied considerably between schools. For dairy products, mixed findings were noted; in school C the choice of dairy increased and in school A it decreased over the study period. The choice of fruits and vegetables at lunch was significantly increased only in school C, and that of starchy foods increased in schools B and C. Choices of desserts decreased in schools B and C and cheese decreased in school C. Overall, school C showed changes consistent with healthy nutrition policies for all food groups, whereas in school A, no significant changes were noted over the course of the study. In school B, some changes in food choice competencies (starch and cheese) were noted consistent with the recommendations. Overall BMI *z*-score and prevalence of obesity decreased significantly during

Table 1. Study Population and School Characteristics

Children eligible for final analyses	Overall (n = 350)	School A (n = 84)	School B (n = 88)	School C (n = 178)	P[c]
Age, y (mean ± SD)	13.3 ± 1.0	13.2 ± 0.9	13.3 ± 1.1	13.4 ± 0.9	ns
Overall number of days of use	72	72	78	67	
Median per child, n (range)	39 (7–66)	22 (7–42)	23 (7–66)	52 (7–60)	< .001
Sex ratio (% female)	55	67	49	53	< .040
Body mass index (*z*-score)	0.50 ± 1.08	0.33 ± 0.89	0.40 ± 1.08	0.63 ± 1.15	ns
Obesity (%)[a]	12.3	2.4	10.2	18.0	.001
Physical activity level (% low/ med/high)[b]	23/53/24	37/50/13	22/58/20	17/53/30	< .010
School location	Toulouse area	Downtown	Outskirts of town	Private housing estate	
Environment for use of kiosks	Good	Not good	Fair	Excellent	

ns indicates not significant.
[a]Defined as body mass index > 97th percentile, according to French reference curves (Rolland-Cachera); [b]Self-declared; [c]$P < .05$ was considered significant.
Note: Paired *t* test or Wilcoxon matched-pairs signed-rank test were used for matched continuous variables, and McNemar test was used for matched qualitative variables.

Table 2. Change in Children's Food Choices and Anthropometric Measures at End of Study vs Baseline

	Overall (n = 350)			School A (n = 84)			School B (n = 88)			School C (n = 178)		
	Baseline	End of Study	P	Baseline	End of Study	P	Baseline	End of Study	P	Baseline	End of Study	P
Children's choices												
Dairy products	70.0	74.2	.030	75.8	67.0	.040	44.7	47.3	ns	79.8	90.8	< .001
Cheese	22.1	15.9	.002	37.3	42.5	ns	41.7	19.3	< .001	5.2	1.7	.002
Starch	94.9	96.8	.030	93.7	92.1	ns	95.1	98.5	.010	95.3	98.1	.020
Fruits and vegetables	92.2	94.4	.050	98.0	96.8	ns	98.1	95.5	ns	86.5	92.7	.001
Pastry, ice cream, dessert	30.3	23.1	< .001	23.8	18.7	ns	23.5	28.4	ns	36.7	22.7	< .001
Anthropometric measures												
Body mass index (*z*-score)	0.50 ± 1.08	0.43 ± 1.03	< .001	0.33 ± 0.89	0.37 ± 0.81	ns	0.40 ± 1.08	0.24 ± 1.06	< .001	0.63 ± 1.15	0.55 ± 1.10	.001
Obesity (%)[a]	12.3	10.3	.040	2.4	2.4	ns	10.2	10.2	ns	18.0	14.0	.008

ns indicates not significant.
[a]Defined as body mass index > 97th percentile, according to French reference curves (Rolland-Cachera); $P < .05$ was considered significant.
Note: Baseline is the first 3 connections; the end of study is the last 3 connections. Results are expressed as percentages of children's choices for lunch meal over 3 connections. Dairy includes yogurt and *fromage blanc*. Starch includes bread, rice, pasta, potatoes, beans, and lentils. Variance analysis (ANOVA) was used for matched continuous variables, and chi-square test was used for matched qualitative variables.

the intervention period. The BMI *z*-score change was significant in 2 of the 3 schools, and change in obesity was significant in 1 of the 3 schools.

The increased choice of dairy products, fruits and vegetables, and starchy foods at lunch, consistent with nutritional messages provided by the *Nutri-Advice* system, was significantly correlated with the number of times children connected with the interactive system (Table 3). Furthermore, the decrease in dessert choices was correlated with the increased number of sessions with the interactive system. The decrease in BMI *z*-score during the intervention period was not correlated to the number of sessions.

DISCUSSION

Multimedia devices are attractive, adaptive, and cost effective tools to spread learning and prevention programs through broad populations. During the past decade, a surge of studies using interactive media interventions have been published to treat overweight in children and adolescents. Systematic reviews[17,18] report small changes in diet, physical activity, and knowledge in most studies. A teenage or an adult population could be targeted in 2 main ways. First, the serious game or lessons concept[9,19-22] is the most widely used and allows interaction in virtual situations. On the other hand, the real-life experiment concept should allow different teaching strategies to be developed or to reach different learning goals. *Nutri-Advice* is a game, but it is based on real-life situations provided by cafeteria menus. Its aim is to achieve the goals of attracting and maintaining attention through day-to-day, practical, and personalized counseling. In this way, *Nutri-Advice* could be considered complementary to previously reported multimedia nutrition teaching tools, completing the childhood to adulthood learning chain.

A first main research question deals with the link between the use of the interactive kiosk by middle school children in a school cafeteria and improvement of their food choice competencies. Results of this study lend support to the feasibility

Table 3. Correlation Between Total Number of Connections to Device and Evolution of Food Choices and Body Mass Index

	Pearson Correlation Coefficient	*P*
Dairy products	0.15	< .01
Cheese	−0.02	ns
Starch	0.11	< .05
Fruits and vegetables	0.15	< .01
Pastry, ice cream, dessert	−0.14	< .01
z-score body mass index	−0.03	ns

ns indicates not significant.

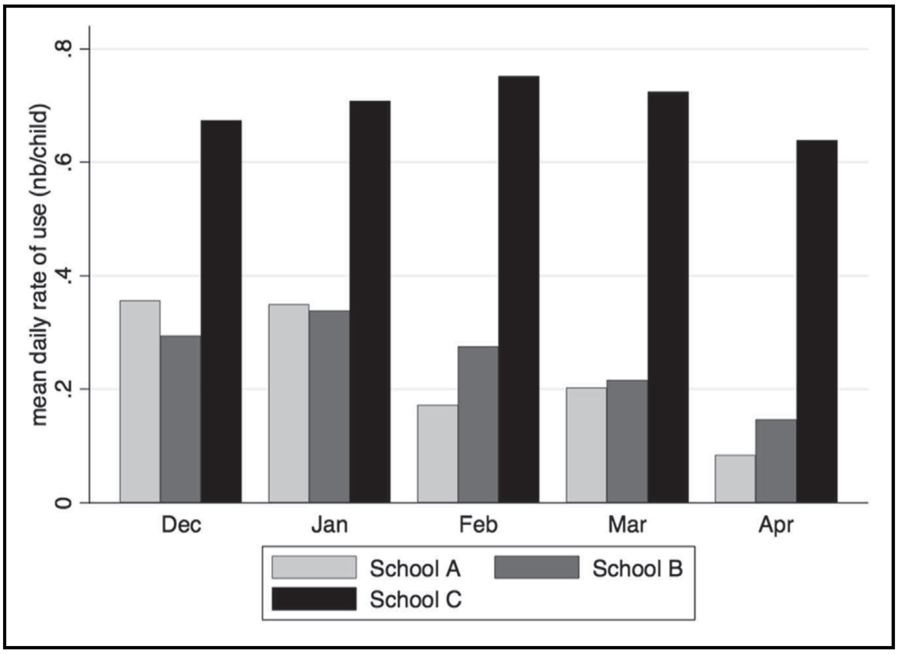

Figure 3. Frequency of kiosk use. For school C it exceeded 0.7, meaning that children used it on most occasions. For a given month, nb/child is the ratio between the number of actual uses and the number of possible uses of the kiosk, for all children of a school.

of the intervention. This learning intervention did not require teachers to spend extra classroom time or adapt teaching methods. The kiosks were well accepted by school children. Choosing correctly among daily dishes available at the cafeteria allowed practical learning of basic knowledge and know-how regarding nutrition. These concepts are difficult to explain through lectures involving notions such as the existence of significant interindividual variability in food needs and the importance of respecting general nutrition rules.

The researchers observed significant differences in prevalence rates of obesity because of where the 3 schools were located: 1 downtown, the other in the close periphery, and the last in a suburban area. It has been shown that differences in socioeconomic status lead to differences in eating habits.[23] Because middle schools situated the kiosks at their convenience, large differences in kiosk use were also observed. In school C, where use was highest, the kiosk was easily accessible near the cafeteria entrance, and its use was promoted by school staff. Some of these conditions were not met by schools A and B, which led to marked differences in kiosk use (Figure 3).

Comparing the first and the last 3 uses of the kiosk implies that comparison of identical possible choices was not assessed. This could be considered a bias because the observed differences could have resulted from variations in the menus rather than improvements in children's nutritional competencies. However, the way the software assesses meals is independent of their particular composition. Also, the cafeteria lunches generally have a constant meal composition across the school year, in accordance with official guidelines. Moreover, the significant correlation between the number of times children used the kiosk and the changes in their choices strongly supports the hypothesis of a direct influence of the system on the children's eating choices.

On the whole, the children's choices changed in line with the PNNS recommendations. Specifically, the choice of dairy products, starch, and vegetables and fruits increased significantly over the course of the study and the choice of desserts decreased. These results suggest that whereas cafeteria choices can be considered broadly consistent with general nutritional recommendations, thus minimizing extremely imbalanced choices, there is still room for improvement through personalized counseling by means of interactive personalized multimedia approaches. This point is of primary interest for future nutrition intervention programs, because cafeteria lunch is the meal most controllable by children and teenagers; they can choose their own meal.

Finally, these results suggest that the children and teenagers who used the kiosks showed several trends toward improving their nutritional competencies about how to balance their school lunch food choices.

The second main research question deals with the impact of nutrition education on childhood obesity. The researchers bserved significant changes only in the school with the highest prevalence of obesity and where children used the system most (school C). Participation was voluntary for children, which led to an imbalance in sample sizes among schools. The weight of school C in the overall results approximately equals the sum of the weights of the other 2 schools. These differences prevented the researchers from performing a subgroup analysis based on BMI categories or frequency of use, because the imbalanced distribution between schools would have introduced a bias. Further studies could explore whether children who use the device most are the most overweight. Finally, a modest but significant decrease in BMI was observed; further studies with control groups might confirm the causal link between the intervention and BMI improvement.

IMPLICATIONS FOR RESEARCH AND PRACTICE

Personalized nutrition counseling through a free-access, standalone multimedia device is feasible in the school environment and has the potential to improve the food choice competencies of children and teenagers. Further studies in broader populations with greater sample sizes, conducted over a longer time, are needed to confirm these preliminary promising results and identify the population profile that would benefit most from the use of interactive multimedia systems.

The software developed for this study can be used in any school or company cafeteria. It includes several modules designed to be easily employed by nontechnical personnel, whether the recipe entry module will be used by the kitchen staff or the dietitian, the daily menu entry module will be used by administrative staff, or the interactive application will be used by children at the kiosk. Because the application for children was designed as a game, it was quickly adopted by them, creating favorable conditions to conduct other educational activities on the topic of nutrition.

The balanced food module of the software has since been used as one of the main tools in a diabetes telemonitoring project.

ACKNOWLEDGMENTS

This study was supported by the University Hospital of Toulouse and by grants from the Foundation for Medical Research as well as the French Health Ministry for the implementation of PNNS. The research received approval from the Ethical Committee for Biomedical Research, Toulouse, France, and the National Committee for Information and Liberty, Paris, France. The authors are grateful to the school principals, teachers, and kitchen staff as well as the students who participated in this study.

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