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HOW WE TEACH | *Generalizable Education Research*

Impact of a playful booklet about diabetes and obesity on high school students in Campinas, Brazil

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Soares GM, Zangerolamo L, Rosa LR, Branco RC, Carneiro EM, Barbosa-Sampaio HC. Impact of a playful booklet about diabetes and obesity on high school students in Campinas, Brazil. *Adv Physiol Educ* 43: 266–269, 2019; doi:10.1152/advan.00160.2018.— Obesity and diabetes are two of the biggest public health problems in the modern world. One possible way to combat the rising prevalence of these diseases is through the spread of awareness about its consequences and how to prevent them. Therefore, educational interventions focused on teaching the physiological basis of these conditions might be valuable tools. However, most scholar curriculums lack high-quality material devoted to this topic. Thus we developed an educational booklet, composed of playful elements, targeted toward high school students and destined for application in classrooms. The efficacy of the developed material was validated through a pretest-posttest design, in which the students had to answer a 10-question test. After booklet completion, students had better outcomes, with an increase in the percentage of correct answers in 7 out of 10 questions contained in the test ($P < 0.05$). Thus we developed an effective material for usage in the high school classroom to spread the awareness of the risks of metabolic diseases and how to prevent them.

booklet; diabetes; educational intervention; obesity; playful

INTRODUCTION

Obesity is a chronic disease that has drastically increased worldwide over time, doubling its prevalence in the past 35 yr (3). In 2014, 11% of the male and 15% of the female population around the world were obese (3). If this situation persists, one-half of the world's population could be obese in 2030 (22). In addition, there is also a large economic burden associated with obesity. Data from 2014 demonstrated that the costs related to obesity, including healthcare and productivity loss associated with mortality and disabilities, were estimated to be around US $2 trillion, which corresponds to almost 3% of the worldwide gross domestic product (22).

Furthermore, diabetes is also a widespread disease, affecting more than 451 million people around the world. These numbers are expected to reach 693 million in 2045 (7). The economic burden of diabetes is estimated to be US $1.8 trillion, or 1.8% of the global gross domestic product (6). Obesity and diabetes are intrinsically related, with obesity being a risk factor for type 2 diabetes development (11). Both diseases can trigger multiple consequences (5, 20). Therefore, obesity and diabetes are major public health problems of the modern world.

In both cases, prevention is better and cheaper than treatment, and information is crucial to proper prevention (2). This type of information can be provided through the dissemination of healthy habits, such as healthy eating, regular physical exercise, and the establishment of a solid foundation of biological knowledge to the intended audience. In this context, previous studies have provided evidence that educational efforts can help individuals who are already overweight or obese (15) and promote short-term behavioral and nutritional changes in students (1).

Among the existing educational interventions, the distribution of educational brochures and booklets can be considered as an alternative. Multiple studies have repeatedly shown their efficacy in improving awareness and learning in different audiences, for various diseases and conditions (4, 18, 23), including obesity (19). Moreover, recreational and playful approaches, like games and activities, have also shown efficacy in promoting health-related awareness, information, and action (8), as well as changes in behaviors associated with obesity (16).

Therefore, our group developed an educational booklet focused on educating students about obesity and diabetes. The booklet was developed with theoretical information in accessible language and playful nature elements like games and questions. This booklet was applied in a group of high school students, in a pretest-posttest experimental design to evaluate its efficacy, in an attempt to create a material that can be used by the teaching community worldwide.

METHODS

Booklet production, games, and activities. This booklet was produced as part of an outreach initiative from our group, the Obesity and Comorbidities Research Center, at the Institute of Biology, University of Campinas. The booklet is filled with illustrations to make it more engaging to the audience. The bulk of the booklet's content is dedicated to games and enigmas, which were designed and arranged in rising order of difficulty and broadness of subject, in most cases. Thus the first activities are merely expository or playful, followed by activities that demand small knowledge on limited topics, and, finally, activities that demand more knowledge on broader topics. The activities are as follows: an instructional text about diabetes and obesity, a labyrinth game, a symbol alphabet game, a word hunt, a "What gland

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am I?" game, an anagram game, a questions game, a "complete the text" game, a column association game, a crossword puzzle, a "glycemic curve" exercise, and a memory game. The booklet was given to the participating students, and they had 1 h to complete its activities as best as they could.

Research participants. For this study, we used a consent form (see Supplemental Material, available at https://doi.org/10.6084/m9.figshare.8064116), containing information about our research, as well as an agreement statement accepting participation in the study anonymously. This form was signed by a parent or a legal guardian, or by the student if he/she was of legal age. The booklet was given to a group of 64 high schoolers, which corresponds to all of the students who were present in the class in the days we performed the pretest and the posttest, characterizing a random assignment study. Importantly, the students did not receive any prizes to be part of the study; all of them participated on their own. The pretest quiz was applied for the students 1 wk before the booklet application. Participating students came from all 3 yr of the Brazilian high school educational system and varying socio-economic backgrounds.

Student testing and data analysis. A 10-item quiz was prepared by our team to be applied in the classroom (see Supplemental Material; https://doi.org/10.6084/m9.figshare.8064116), to gauge high school students' knowledge about the physiological and biochemical basis of obesity and diabetes. The quiz was also used to gauge the impact of the booklet on students' answers on the chosen subjects. Quizzes were issued to the participants, and they were given 15 min to complete it. The questions were applied 1 wk before the students had contact with the booklet's content, and then reapplied 1 wk after they had contact with the booklet. Students were not aware they would be posttested. Results were analyzed with a Wilcoxon test, and $P < 0o05$ was considered significant. After the end of the activities, the member of our team responsible for the booklet application discussed the activities and topics with the students and presented the correct responses.

RESULTS

Booklet. The booklet is provided as supplemental material through the publication of this paper for the usage of the teaching community worldwide (see https://doi.org/10.6084/m9.figshare.8064116). The booklet is already complete with design, illustrations, and activities in their proper order, ready for printing and usage.

Student interest and engagement. The playful nature of the elements used in the booklet showed positive outcomes regarding the students' engagement in this study. During the application of the booklet, the students demonstrated higher interest and engagement than what we expected from a traditional expository class. Students spoke with each other and with the booklet applicator, establishing a two-way discussion on the proposed subject. In addition, many students remained engaged in the proposed activities even after the class was over.

Questions performance. Table 1 show the percentage of correct answers given for each question, before and after the booklet application. Students' performance on *questions 2–6* and *8–10* improved after the contact with the educational booklet. The greatest improvements were observed for *questions 5* (36%), *8* (19%), and *6* (15%). The performance on *question 1* decreased (9%), while no difference in percentage of correct answers was observed for *question 7*, both before and after the booklet. Overall, students' performance on the quiz improved after the completion of the booklet, presenting a significant increase in the percentage of correct answers (Fig. 1, $P = 0.0195$).

Table 1. *Performance on correct answers before and after booklet application*

	Pretest ($n = 64$)		Posttest ($n = 64$)		
Question No	*n*	%	*n*	%	*P* Value
1	63	98	57*	89	0.0197
2	40	63	47*	73	0.0107
3	24	38	26	41	0.3458
4	52	81	57*	89	0.0369
5	33	52	56*	88	<0.0001
6	17	27	27*	42	0.0019
7	7	11	7	11	1.0000
8	31	48	50*	78	<0.0001
9	40	63	51*	80	0.0011
10	45	70	52*	81	0.0107

Values are *n*, no. of students, who correctly answered the question for pretest vs. posttest, with percentages of correct answers. *Significant difference (Wilcoxon, $P < 0.05$).

DISCUSSION

Our data show that the application of this educational booklet successfully increased the student' awareness of the evaluated subjects (metabolism, obesity, and diabetes). We observed a significant increase in the percentage of correct answers of the quiz, after the students had contact with the material, indicating the effectiveness of the material developed in this study. Pretest-posttest research designs have been widely used as a mechanism to evaluate educational or training interventions in many studies, which encompass a multitude of subjects (9, 10). Thus it is considered as an adequate tool for the evaluation of the student's retention of knowledge.

This study started as an outreach initiative from our group, aiming to spread awareness about the risks of metabolic diseases, as well as a way of returning to the society the support they give us as obesity researchers. However, as we developed the material, we realized that there is a clear lack of nutritional information in basic education. A study by Naeeni and colleagues (13) found deficiencies in nutritional education and imbalanced diets, in children and adolescents. Then we realized that we had an amazing opportunity to develop an inter-

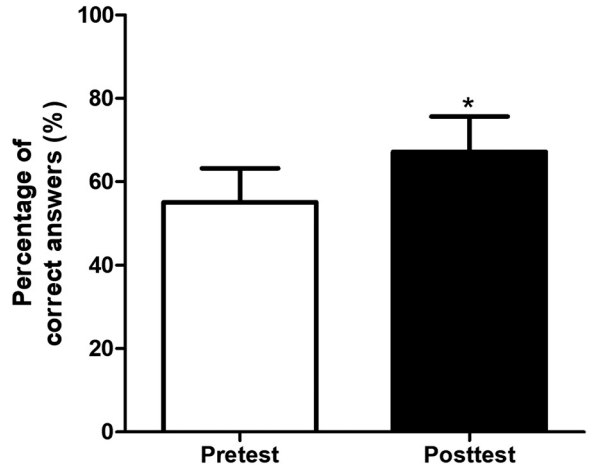

Fig. 1. Performance of the students on the 10 questions of the quiz. Data show the percentage of correct answers by students in the pretest and the posttest. All 10 questions of the quiz were taken into consideration. Values are means ± SE. *$P \leq 0.05$ (Wilcoxon test).

nationally useable educational material to supply the demand for information about healthy nutritional habits.

There is controversy on the effectiveness of nutritional education on prevention of obesity and other metabolic disorders. Many studies found no correlation between nutritional information and reduction of body mass index or obesity prevention (14, 24). However, a study from 2013 demonstrated that the impact of nutritional information on obesity prevention depends on the expectation of food availability (EFA) (21). The spread of nutritional information promoted improvement of dietary quality in situations in which EFA was increased, such as food price lowering or food coupon programs. The author also noted that, when analyses were conducted without considering the impact of EFA, the effects of nutritional knowledge seemed smaller (21). Thus these data indicate that nutritional education improves dietary quality and helps to combat metabolic diseases. The application of our booklet may be more effective in countries experiencing increase in EFA.

Some challenges worked against the quality of our data during the application of the booklet. It is notably hard to engage high school students and stimulate them to fulfill the activities. Especially considering that the booklet was completed as an optional activity with no rewards for compliance. Even though we noticed increased engagement when compared with previous experiences in expository classes, the students were not fully compromised to the activities. It is important to note that students' involvement could be dependent on each student's personality and predispositions for educational engagement. There were also two questions that indicated unsatisfactory results, and it is unclear why the students performed poorer on those questions in comparison to the others. Another factor that worked against our posttest results was the period of application: students were tested 1 wk after they had contact with the material, which characterizes long-term retention of information (12, 17). Naturally, short-term retention is considerably easier than long-term retention, and our design intentionally made it harder to detect a significant difference. Despite all of the limitations, the booklet had successful results by increasing long-term knowledge regarding physiological and biochemical subjects associated with metabolism, obesity, and diabetes in a playful context, for high school students in Brazil.

Therefore, we have developed an effective material to spread the awareness of diabetes and obesity, as well as established a basis of physiological knowledge about these topics and metabolism in general. This material is readily applicable by the teaching community worldwide and can be used in the classrooms or in outreach initiatives on high school level audiences.

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DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS

G.M.S., L.Z., and H.C.d.L.B.-S. conceived and designed research; G.M.S., L.Z., and L.R.d.O.R. analyzed data; G.M.S., L.Z., L.R.d.O.R., E.M.C., and H.C.d.L.B.-S. interpreted results of experiments; G.M.S., L.R.d.O.R., and R.C.S.B. prepared figures; G.M.S., L.Z., L.R.d.O.R., R.C.S.B., E.M.C., and H.C.d.L.B.-S. edited and revised manuscript; G.M.S., L.Z., L.R.d.O.R., R.C.S.B., E.M.C., and H.C.d.L.B.-S. approved final version of manuscript; L.Z. performed experiments; L.R.d.O.R. and H.C.d.L.B.-S. drafted manuscript.

REFERENCES

1. **Ajie WN, Chapman-Novakofski KM.** Impact of computer-mediated, obesity-related nutrition education interventions for adolescents: a systematic review. *J Adolesc Health* 54: 631–645, 2014. doi:10.1016/j.jadohealth.2013.12.019.
2. **Aranceta J, Moreno B, Moya M, Anadón A.** Prevention of overweight and obesity from a public health perspective. *Nutr Rev* 67, *Suppl 1*: S83–S88, 2009. doi:10.1111/j.1753-4887.2009.00166.x.
3. **Arroyo-Johnson C, Mincey KD.** Obesity epidemiology worldwide. *Gastroenterol Clin North Am* 45: 571–579, 2016. doi:10.1016/j.gtc.2016.07.012.
4. **Bester N, Di Vito-Smith M, McGarry T, Riffkin M, Kaehler S, Pilot R, Bwire R.** The effectiveness of an educational brochure as a risk minimization activity to communicate important rare adverse events to healthcare professionals. *Adv Ther* 33: 167–177, 2016. doi:10.1007/s12325-016-0284-y.
5. **Bloomgarden ZT.** Consequences of diabetes: cardiovascular disease. *Diabetes Care* 27: 1825–1831, 2004. doi:10.2337/diacare.27.7.1825.
6. **Bommer C, Heesemann E, Sagalova V, Manne-Goehler J, Atun R, Bärnighausen T, Vollmer S.** The global economic burden of diabetes in adults aged 20-79 years: a cost-of-illness study. *Lancet Diabetes Endocrinol* 5: 423–430, 2017. doi:10.1016/S2213-8587(17)30097-9.
7. **Cho NH, Shaw JE, Karuranga S, Huang Y, da Rocha Fernandes JD, Ohlrogge AW, Malanda B.** IDF diabetes atlas: global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes Res Clin Pract* 138: 271–281, 2018. doi:10.1016/j.diabres.2018.02.023.
8. **Coscrato G, Pina JC, Mello DF.** Utilização de atividades lúdicas na educação em saúde: uma revisão integrativa da literatura. *Acta Paul Enferm* 23: 257–263, 2010. doi:10.1590/S0103-21002010000200017.
9. **Dauer LT, Kelvin JF, Horan CL, St Germain J.** Evaluating the effectiveness of a radiation safety training intervention for oncology nurses: a pretest-intervention-posttest study. *BMC Med Educ* 6: 32, 2006. doi:10.1186/1472-6920-6-32.
10. **Delucchi M.** Measuring student learning in social statistics: a pretest-posttest study of knowledge gain. *Teach Sociol* 42: 231–239, 2014. doi:10.1177/0092055X14527909.
11. **Golay A, Ybarra J.** Link between obesity and type 2 diabetes. *Best Pract Res Clin Endocrinol Metab* 19: 649–663, 2005. doi:10.1016/j.beem.2005.07.010.
12. **Karpicke JD, Roediger HL III.** Repeated retrieval during learning is the key to long-term retention. *J Mem Lang* 57: 151–162, 2007. doi:10.1016/j.jml.2006.09.004.
13. **Naeeni MM, Jafari S, Fouladgar M, Heidari K, Farajzadegan Z, Fakhri M, Karami P, Omidi R.** Nutritional knowledge, practice, and dietary habits among school children and adolescents. *Int J Prev Med* 5, *Suppl 2*: S171–S178, 2014. doi:10.4103/2008-7802.157687.
14. **O'Brien G, Davies M.** Nutrition knowledge and body mass index. *Health Educ Res* 22: 571–575, 2007. doi:10.1093/her/cyl119.
15. **Ostovan MA, Zibaeenezhad MJ, Keshmiri H, Shekarforoush S.** The impact of education on weight loss in overweight and obese adults. *Int Cardiovasc Res J* 7: 79–82, 2013.
16. **Perez-Lizaur A, Haua-Navarro K, Moreno-Landa LI.** Effects of a health promotion program for children on lifestyle and health indicators. *FASEB J* 28, *Suppl* 1: 1021–1025, 2014.
17. **Pyc MA, Balota DA, McDermott KB, Tully T, Roediger HL III.** Between-list lag effects in recall depend on retention interval. *Mem Cognit* 42: 965–977, 2014. doi:10.3758/s13421-014-0406-1.
18. **Redman S, Paul C.** A review of the effectiveness of print material in changing health-related knowledge, attitudes and behaviour. *Health Promot J Austr* 7: 91, 1997.
19. **Rune KT, Mulgrew K, Sharman R, Lovell GP.** Effect of an obesity pamphlet on parental perception and knowledge of excess weight in their children: results of a randomised controlled trial. *Health Promot J Austr* 26: 129–132, 2015. doi:10.1071/HE14060.
20. **Segula D.** Complications of obesity in adults: a short review of the literature. *Malawi Med J* 26: 20–24, 2014.
21. **Shimokawa S.** When does dietary knowledge matter to obesity and overweight prevention? *Food Policy* 38: 35–46, 2013. doi:10.1016/j.foodpol.2012.09.001.

22. **Tremmel M, Gerdtham U-G, Nilsson PM, Saha S.** Economic burden of obesity: a systematic literature review. *Int J Environ Res Public Health* 14: 435, 2017. doi:10.3390/ijerph14040435.
23. **Ul Haq N, Tahir M, Iqbal Q, Naseem A, Masood I.** Effect of educational intervention on osteoporosis knowledge among university female students in Quetta, Pakistan. *Value Health* 18: A877, 2015. doi:10.1016/j.jval.2015.09.048.
24. **Zhou L, Zeng Q, Jin S, Cheng G.** The impact of changes in dietary knowledge on adult overweight and obesity in China. *PLoS One* 12: e0179551, 2017. doi:10.1371/journal.pone.0179551.