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SCHOOL-BASED BEHAVIOURAL INTERVENTION TO FACE OBESITY AND PROMOTE CARDIOVASCULAR HEALTH AMONG SPANISH ADOLESCENTS: A CLUSTER-RANDOMIZED CONTROLLED TRIAL

Rosa Maria Lamuela Raventós
Facultat de Farmàcia Universitat de Barcelona - Fundació Bosch i Gimpera
Gloria Santos Beneit
Foundation for Science, Health and Education Fundación She – Barcelona
Juan Miguel Fernández Alvira
CNIC Centro Nacional de Investigaciones Cardiovasculares Carlos III – Madrid

1. Project summary

There is an alarming increase in obesity and unhealthy lifestyles among adolescents. Our main objective was to evaluate the efficacy of a comprehensive educational intervention in adolescents in the school setting on cardiovascular health, including obesity/adiposity and metabolic profiles. The project consortium constitutes a unique opportunity for cutting-edge research groups to try new approaches with the aim of achieving healthier dietary behaviors and habits.

The main objective was to evaluate the efficacy of a health education intervention (Programa SI! de Secundaria), focused on the acquisition and maintenance of healthy habits, on the cardiovascular health of adolescents, including obesity/adiposity parameters. With this objective, a cluster-randomized controlled trial was carried out in which 24 secondary schools in Spain participated. Schools were randomized according to a 1:1:1 pattern to receive a short-term (2-year) or long-term (4-year) comprehensive educational program, or to receive the usual (control) curriculum.

The aim of the intervention is to improve cardiovascular health through the acquisition and maintenance of healthy behaviors. An intervention of 12 hours per year was designed for the 4 years of secondary school (1st ESO, 2nd ESO, 3rd ESO and 4th ESO), and another of 18 hours per year for the first 2 years (1st ESO, 2nd ESO), following the same health objectives: promoting healthy eating, promoting physical activity, and avoiding the consumption of toxic substances (especially tobacco). The educational objectives of each course were adapted to the curriculum and have been worked on at different levels of intervention: classroom, teachers, school and family environment.

The health objectives of the Program are worked on in the classroom in a cross-cutting manner through different subjects. The work in the classroom is organized through three didactic units, and with active and participative methodologies. The didactic units are set in an intriguing adventure, with which curricular contents are worked on with a special focus on the promotion of cardiovascular health. Each didactic unit contains several classroom activities called

missions, and in each year of secondary education a different thematic axis is worked on.

This work in the classroom is accompanied by gamification through a virtual platform, designed so that students can keep track of their physical activity outside the center and thereby earn points that will help their class advance along the virtual journey that the program offers them. In addition, there is a reward system managed by the teacher, as a reinforcement strategy for the student; and an adventure book for the student to collect and reinforce their learning. The teacher can access all the contents of the SI! Secondary Program from this platform.

Gamification uses different resources such as rewards, motivational phrases, mini-games, interactive animations, videos and the completion of an electronic adventure notebook.

To involve families in the health program, we send them newsletters with information about healthy habits. Three are sent each school year from 1st to 3rd ESO, one for each health objective.

The intervention at the teacher level is based on training received by the research team to apply classroom activities, gamification, and to be a motivational and change agent. Each institute appoints a health coordinator, who is the person in charge of promoting cardiovascular health in the center. Their main functions are to be the liaison between the school and the SHE Foundation Zone Coordinator, and to monitor the progress of the SI! program in the school. All teachers can take the training, but it is mandatory for the health coordinator.

For the promotion of cardiovascular health at the school-environment level, a document is offered with 10 recommendations for actions to promote and plan in the

educational center: 1) Active playgrounds; 2) Healthy snacks; 3) Healthy food in the lunch machines and/or canteen; 4) Travel to the educational center on foot or by bicycle; 5) Motor wedges and moments of rest/relaxation during the school day; 6) Encourage the participation of families in health promotion; 7) Appropriate use of technologies; 8) Healthy celebrations; 9) System of mediation and conflict resolution in the center; 10) Activities to develop social and personal competencies. In addition, every year, the Health Week is held, in which the health coordinator and the rest of the teaching and management team work together in the programming of activities and workshops related to the four health objectives, favoring the active involvement of teachers, students and families.

The primary endpoint of intervention efficacy was the change in obesity and other health parameters between baseline assessment and 2- and 4-year follow-up, assessed using the Ideal Cardiovascular Health Score (ICH), developed by the American Heart Association (Lloyd-Jones et al., 2010).

Secondary evaluation criteria include: 1) analyzing the change in body mass index, waist circumference, and adiposity measured by bioelectrical impedance and dual-energy X-ray absorptiometry; 2) to evaluate the association between changes in adiposity parameters and food and nutrient intake, mainly polyphenol intake, assessed by a food consumption frequency questionnaire and by biochemical determination in saliva and urine; 3) to explore the relationship between carotenoid intake and body composition; 4) to evaluate the effect of the intervention on metabolism using a metabolomic approach; 5) to study the association between the level of physical activity and changes in adiposity parameters through questionnaires and accelerometry; 6) to evaluate the relationship between attitudes and habits and changes in adiposity; 7) to evaluate individually the maintenance of changes in cardiovascular health components and biological parameters of normal weight in adulthood; 8) to compare the effectiveness of the short versus long educational intervention; and 9) to validate a noninvasive cardiovascular health index (FBS, Fernández-Alvira et al., 2017).

We expect to demonstrate that an educational intervention in school children induces favorable lifestyle changes and improves cardiovascular health among Spanish adolescents, including obesity/adiposity and metabolic profiles. If successful, this

strategy could be widely adopted having a significant effect on obesity and cardiovascular health promotion. In addition, associations of health parameters with the intake of bioactive compounds and metabolic profiles would be established.

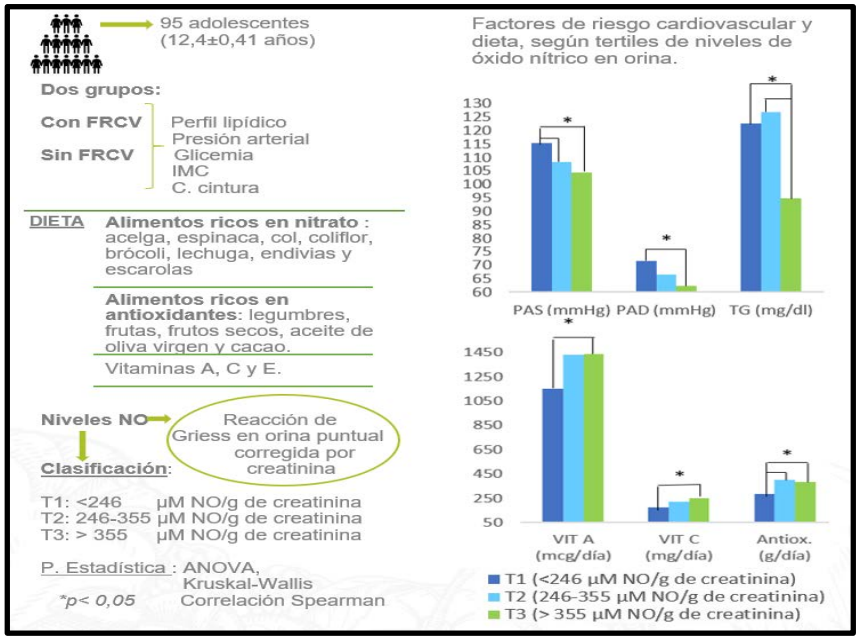
2. Results obtained

The most relevant results obtained, which have already been published in scientific journals, are presented below:

Most adolescents present one or more cardiovascular risk factors. Only 11% have cardiovascular health considered ideal. The most prevalent risk factor is poor nutritional habits, with only 0.6% of adolescents reporting ideal habits. The worst scores are related to lower purchasing power, lower parental education level, and migrant origin (Fernández-Jiménez et al. 2020).

For the first time in an adolescent population, urinary polyphenol levels have been directly correlated with an improved cardiovascular profile, especially in boys. More specifically, higher urinary polyphenol levels correspond to a lower percentage of body fat, lower plasma concentrations of triglycerides, total cholesterol and LDL cholesterol, higher HDL concentration and lower blood pressure (Laveriano-Santos et al. 2020).

The quantification of total polyphenols in urine samples has been shown to be, also in the adolescent population, a good biomarker of intake of polyphenol-rich foods, such as fruits, vegetables, whole grains, nuts, olive oil and coffee.



The concentration of nitric oxide in the urine of adolescents correlated directly with polyphenol intake in the pilot study. The importance of this relationship lies in the fact that nitric oxide is inversely related to blood pressure, so that it can be deduced that the effect of polyphenols on blood pressure would be mediated by this compound. The results in the study population go in the same direction.

The diet of the participants was classified into 3 highly differentiated eating patterns: diet rich in processed foods (29% of the adolescents), traditional diet (39%), and healthy diet (32%). However, these patterns were either not associated with improved cardiovascular risk factors or the associations were too weak to be considered relevant (Bodega et al. 2019).

At the end of the intervention program in the high schools (end of the 2020-2021 school year), the data from the last assessment, carried out between January and June 2021, will be cleaned. Once the final database has been processed, the research team will analyze the effect of the school intervention on the cardiovascular health of the participants, in accordance with the main objective of the study. Similarly, the other secondary objectives not previously achieved will be addressed, relating to the change in parameters in the successive measurements.

3. Relevance to possible future implications

It is expected that this school intervention in terms of nutrition, physical activity and healthy habits will have a direct impact on the health of school children, reducing cardiovascular risk parameters and thus improving their present and future health. The impact at the economic level is beyond the scope of the present study. One of the strong points of the project is that the intervention has been specially designed to motivate students to follow it, working the contents from the game (gamification). In this intervention, not only nutrition, the promotion of physical activity, toxic habits or the importance of sleep are addressed, but also the control of emotions and knowledge of one's own body, as an empowering element that has to help them grow and form their adult personality.

If the effectiveness of this intervention is demonstrated, and once it is determined whether the best way to carry it out is in 2 or 4 years (more or less intensive, respectively), the program could be introduced as part of the curriculum in those centers that wish to do so, since its transversality allows it to be integrated into subjects as diverse as natural sciences, physical education or tutoring, among others. The education of school children is not only an investment in the future for themselves, but also for future generations. The study will also make it possible to identify the most vulnerable groups or the most influential risk factors, so that actions can be intensified in these specific groups.

4. Scientific bibliography generated

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