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Short Communication

The Microbiological@mind project: a public engagement initiative of Turin University bringing microbiology and health education into primary schools

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ABSTRACT

Despite ongoing global efforts, antimicrobial resistance continues to threaten the treatment of an ever-increasing range of bacterial infections. There is substantial evidence that public education programs that foster microbial literacy amongst young school audiences may improve correct knowledge of specific health issues, such as prevention of microbial infections and responsible use of antibiotics. The aim of the Microbiological@mind project was to engage primary school students with the subject of microbiology, to promote both scientific interest and awareness towards correct behaviors that may ensure a safer lifestyle. Interactive workshops based on a full "hands–on" approach were carried out by an expert team from the University of Turin to over 1200 children aged 9–11 years at primary schools in Turin. A questionnaire (pre- and post-activity test) on the main topic (i.e. antibiotics) was used to assess project effectiveness. The workshops provided a useful means to strengthen the understanding of basic microbiology concepts amongst students. Students' baseline knowledge of antibiotics was quite low, as low percentages of correct answers on antibiotic action and use (5.0% and 12.1%, respectively) were found in the pre-activity tests. A significant increase ($P < 0.0001$) in correct knowledge was observed in the post-activity tests, after implementation of the teaching activity. Our findings support the idea that microbial literacy in early childhood through hands-on educational programs is of great importance to foster children's interest in science learning, and to provide young people with information about general and specific health-related issues, such as prudent antibiotic use, for a more responsible citizenship.

1. Introduction

Nowadays, the spread of antimicrobial resistance (AMR) within pathogenic microorganisms represents a seriously alarming threat to global public health, leading to prolonged hospital stays, treatment failures, and increased healthcare costs [1,2]. In Europe, much effort has been put into educational programs aimed at prescribers and healthcare professionals to optimize antimicrobial therapy and reduce antimicrobial resistance. Many reports have consistently documented that these interventions are fairly effective in reducing antibiotic overuse [3,4]. However, results from the last 2016 Eurobarometer survey, as well as from a cross-sectional study recently conducted in Italy, have shown that many adults still have serious misunderstandings about antibiotics and that children's basic knowledge of antibiotic use is poor [5,6]. Thus, in the past few years, a variety of educational campaigns, such as the 'European Antibiotic Awareness Day' led by the European Centre for Disease Prevention and Control, and many other programs have been proposed to improve global awareness of AMR in the general public, including school-aged children [7,8].

In Europe, the e-Bug project, which was developed in 2006 and is partly funded by the European Commission (DG SANCO), is a representative online education resource that aims to improve young people's understanding of the importance of hygiene and responsible antibiotic use. Currently, e-Bug is led by the Public Health England's Primary Care Unit in England and involves a consortium of 26 international partner countries [8]. In Italy, the Istituto Superiore di Sanità (ISS) is the current e-Bug partner, being directly involved in public health protection [9,10].

In this context, we report the experience of a public engagement initiative promoted by the University of Turin and funded by the Italian Ministry of Education University and Research (MIUR), entitled the *Microbiological@mind project*, which was targeted at

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primary school children. The main aim of the project was to educate children about microbiology, reinforcing awareness of positive behaviors (i.e. hand washing, proper antibiotic use) that may ensure a safer lifestyle. Furthermore, the project was in line with the European Community programs focused on extending science education into primary schools to foster interest in science starting from childhood [11].

In addition, this initiative aimed at strengthening the relationship between the university and the primary schools in the surrounding area.

2. Materials and methods

2.1. Project description and participants

The project started on September 2011, and through 2011–2012, 2013–2014 and 2014–2015 school years scientific workshops were carried out by an expert team from the Department of Public Health and Pediatrics, University of Turin, to a large target audience of over 1200 children aged 9–11 years at 26 different primary schools in Turin. Schools that had not already planned microbiology lessons were asked by e-mail, telephone and letter to participate in this project.

The data analysis of the project was concluded on March 2016.

2.2. Methodological approach

The project combined educational aspects with playful activities and took various forms: 'hands-on' experiments, microscope observation, quizzes, interactive games and team competitions.

The scientific workshops were divided into two distinct 2–h sessions per class, 4–6 weeks apart to enable students to rework content and experiences. A take-home booklet was printed and distributed to all participants, giving the opportunity to include personal notes and statements.

2.3. Planned activities

During the scientific workshops, five main topics were presented: 1) introduction to microbes; 2) spread of infection; 3) the body's natural defences; 4) treatment of infection; and 5) prevention of infection. The workshop activities related to each main topic are described in detail in Table 1. Overall, the educational content and the key learning outcomes were similar to those proposed by the junior pack of the e-Bug website.

2.4. Project evaluation and dissemination

To evaluate project effectiveness and the knowledge change after the teaching activity, pre- and post-activity questionnaires focused on the main topic (i.e. treatment of infection) were administered to students. Students were required to complete identical questionnaires at two different timepoints: 1 week before the first workshop and immediately after the second workshop. Generally, there was at least a 6-week interval between pre– and post-activity tests. Students were asked to tick either 'yes' or 'no' to a simple series of statements. Teachers in every school were in-

Table 1
Classroom planned activities and educational content.

Topic	Activities	Key learning outcomes
INTRODUCTION TO MICROBES	HARMFUL AND USEFUL MICROBES A large gallery of photographs of both useful and harmful microbes (bacteria, yeasts, fungi, and viruses) was projected. Students used these images as a basis to make drawings and/or models of microbes in Petri dishes using play dough (Fig. 1). Children were taught about the microbial communities that normally exist throughout the human body. A simple in vitro experiment of the bread leavening process using baker's yeast (*Saccharomyces cerevisiae*) was carried out.	Microbes are everywhere and are invisible to the naked eye. They have different shapes and sizes. Some harmful microbes can make us ill. Many useful microbes exert beneficial relationships with the human body. Useful microbes also play a key role in food production.
SPREAD OF INFECTION	IMPORTANCE OF EVERYDAY HYGIENE Students were invited to collect different types of samples from skin (before and after hand washing with or without soap), from mouth (before and after teeth cleaning), and from classroom surfaces, using Petri dishes with different growth media, such as Nutrient agar (NA), Mannitol Salt agar (MSA), and Sabouraud Dextrose agar (SDA). NA and MSA plates were transferred by the staff to the university laboratory for further incubation. SDA plates were left in the classroom to enable students to make daily observation of fungal growth (environmental molds). A macroscopic examination of the different colonies of either bacteria or fungi grown on agar plates was carried out. The bacterial load of every student's hands before and after hand washing was observed. Gram-stained slides of bacteria (*Streptococcus spp.*; *Staphylococcus spp.*; *Lactobacillus spp.*; *Escherichia coli*) were viewed under a high-power microscope placed in every classroom. Slides of yeasts (*Saccharomyces cerevisiae*) and molds (*Penicillium spp.*; *Aspergillus spp.*) were also observed under the microscope.	Infection can be spread through direct physical contact between people, airborne droplets from coughing and sneezing or from contact with surfaces and objects. Close environments and inanimate objects serve as resting grounds for microbes. Contaminated hands are the primary mode of transmission of many infectious diseases, particularly among those living in close proximity to one another. Hand washing is the most effective way of reducing the spread of infections caused by harmful microbes.
THE BODY'S NATURAL DEFENCES	BLOOD CELLS AND THE IMMUNE SYSTEM A Diff-Quick stained blood smear was viewed under a high–power microscope to help students identify the white blood cells that make up the body's immune system.	The human body has many natural defenses to fight infection.
TREATMENT OF INFECTION	ANTIBIOTIC ACTION AND USE The discovery of antibiotics was explained to students, giving more information on the benefits of antimicrobial drugs against bacterial infections. Observation of different antibiograms was carried out, followed by expert-led discussion in the classroom.	An appropriate use of antibiotics helps to prevent the development of antibiotic-resistant bacteria and the resulting failure of antibacterial therapies.
PREVENTION OF INFECTION	VACCINES The discovery of vaccines was explained to students, giving more information about the importance of vaccinations in reinforcing the immune system since childhood. Different images of either bacteria or viruses that should be used as a vaccine were projected.	Vaccines introduce an unarmed version of a specific microbe (bacteria or virus) into the body, which helps to teach the body how to fight an infection. Vaccines help to prevent the spread of either bacterial or viral infections within a community.