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Design, Implementation, and Evaluation of the Adolescents and Surveillance System for the Obesity Prevention Project

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Abstract: The Adolescents Surveillance System for Obesity prevention (ASSO) Project aimed at developing standardized and web-based tools for collecting data on adolescents' obesity and its potential determinants. This has been implemented and piloted in the local area of Palermo city, Italy. The aim of the present study is to provide an overview of the Project's design, implementation, and evaluation, highlighting all the aspects for a potential scale-up of the surveillance system on the whole national territory and abroad, as a sustainable and effective source of data.

The overall structure and management, the ASSO-toolkit, the ASSO-NutFit software, and all developed and used procedures for recruiting, training, and data collecting/analyzing are addressed. An interim evaluation has been performed through a feasibility study; a final Project evaluation has been performed reporting the Strengths, Weaknesses, Opportunities, and Threats (SWOT) and the attributes that a surveillance system should have.

This article provides a detailed overview of the Project and highlights that ASSO can be considered a valid, logical, coherent, efficient, and sustainable surveillance system that is consistent with countries' needs and priorities.

The system developed by the ASSO Project provides high-quality data and complies with several characteristics typical of a suitable surveillance system. It has a potential of being adopted within the National Health Service and other countries' Health Services for monitoring adolescents' obesity and its determinants, such as food intakes, behaviors, physical activity, and fitness profiles.

(*Medicine* 95(12):e3143)

Abbreviations: ASSO = Adolescents Surveillance System for the Obesity prevention, BFMF = Body and Fitness Measures Form, BFMT = Body and Fitness Measures Tool, EFSA = European Food Safety Agency, FFQ = Food Frequency Questionnaire, FHQ = Food Habits Questionnaire, FTB = Fitness Tests Battery, HBSC = Health Behavior in School-aged Children Study, PASAQ = Physical Activity, Smoke and Alcohol Questionnaire, PIQ = Personal Information Questionnaire, SLR = Systematic Literature Review, SOP = Standard Operating Procedure, SWOT = strengths, weaknesses, opportunities and threats, WP = Work Package, YRBSS = Youth Risk Behavior Surveillance System.

INTRODUCTION

Obesity and its associated noncommunicable diseases are one of the most common illnesses of childhood and adolescence, and represent an emergent public health issue both in developed and developing countries.[1,2]

Collecting data on adolescents' diet and physical activity behaviors through a standardized surveillance system are essential to assess the entity of contribution of these factors to the obesity development. These data are mostly collected through different instruments,[3] thus not allowing their comparability with other populations coming from similar areas. Data disseminated through such systems could be used for immediate public health action, program planning, evaluation, and formulating research hypotheses addressed to reducing the burden of disease and the costs associated.[4]

Few national surveillance systems have been established worldwide in the field of obesity and adolescents' lifestyles, such as the Youth Risk Behavior Surveillance System (YRBSS)[5] and the Health Behavior in School-aged Children Study (HBSC).[6] In Italy, the article-based HBSC system is currently being up-taken every 2 years to collect health behavior information in adolescents,[7] but the need of a web-based,

Editor: Xiaolin Zhu.
Received: November 25, 2015; revised: February 4, 2016; accepted: March 1, 2016.
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Authors' contributions: GT performed the conception and design of the study, carried it out, analyzed and interpreted data, and drafted the article; NA developed the software and website of the study; EA and AB contributed in the idea of the work and in revising the article critically; ARF performed the statistical analysis and interpretation of data and drafted the article; GN critically revised the statistical analysis; JB, NS, LC, MJ, AF, FV, and CM revised the article critically.
Authors' information: JB is staff members of the WHO Regional Office for Europe. The author alone is responsible for the views expressed in this publication and they do not necessarily represent the decisions or the stated policy of the World Health Organization.
The work has been performed within the Adolescents and Surveillance System for the Obesity prevention (ASSO) Project (code GR-2008-1140742, CUP I85J10000500001), a young researchers project funded by the Italian Ministry of Health.
The authors report no conflicts of interest.
Supplemental Digital Content is available for this article.

ISSN: 0025-7974
DOI: 10.1097/MD.0000000000003143

user-friendly, low-cost, valid, and obesity/fitness-focused instrument has been highlighted recently.[8]

The Project ''An innovative surveillance system for obesity and lifestyles in adolescents applied to the public health service,'' acronym ''ASSO'' (Adolescents Surveillance System for the Obesity prevention), was a research Project funded by the Italian Ministry of Health and involved different national and international partners. It aimed at developing an innovative web-based system for a standardized collection of data on obesity and its potential determinants such as food intakes, behaviors, physical activity, and fitness profiles among adolescents. To this purpose, an ASSO-toolkit including different instruments was developed within the Project, as well as the ASSO-NutFit (Nutrition and Fitness assessment) software allowing a web-based data collection.

The objective of the present study is to provide an overview of the ASSO Project design, with a detailed description of the tools development, as well as the procedures used for sampling, recruiting, training, collecting, and analyzing data. Moreover, an evaluation of the different steps of the Project and a final assessment were performed to estimate how well it operates to achieve its objectives.

METHODS

Design

Overall Structure and Management

The Project was conducted over a period of 4 years (2011–2014) and was structured in 6 Work Packages (WPs), which interrelated to each other as shown in Figure 1.

The principal investigator led a multidisciplinary team including professionals from the fields of nutrition, physical activity, epidemiology, medicine, psychology, informatics, biology, graphics, and communication. Periodical meetings were organized within the Project to discuss on the progresses and different emerging aspects and issues. Results were constantly monitored to control their scientific and technical quality with regard to fulfilling the planned objectives, timing, and spent resources.

Contacts were established with the Regional Education Office, which provided the list of all the schools in the territory, allowing the selection and recruitment of the required sample. Each selected school signed an agreement with the Ministry of Health to perform the activities. Schools provided the structures and equipment for the Project activities, guaranteeing their commitment in recruiting the pupils and their parents' consent.

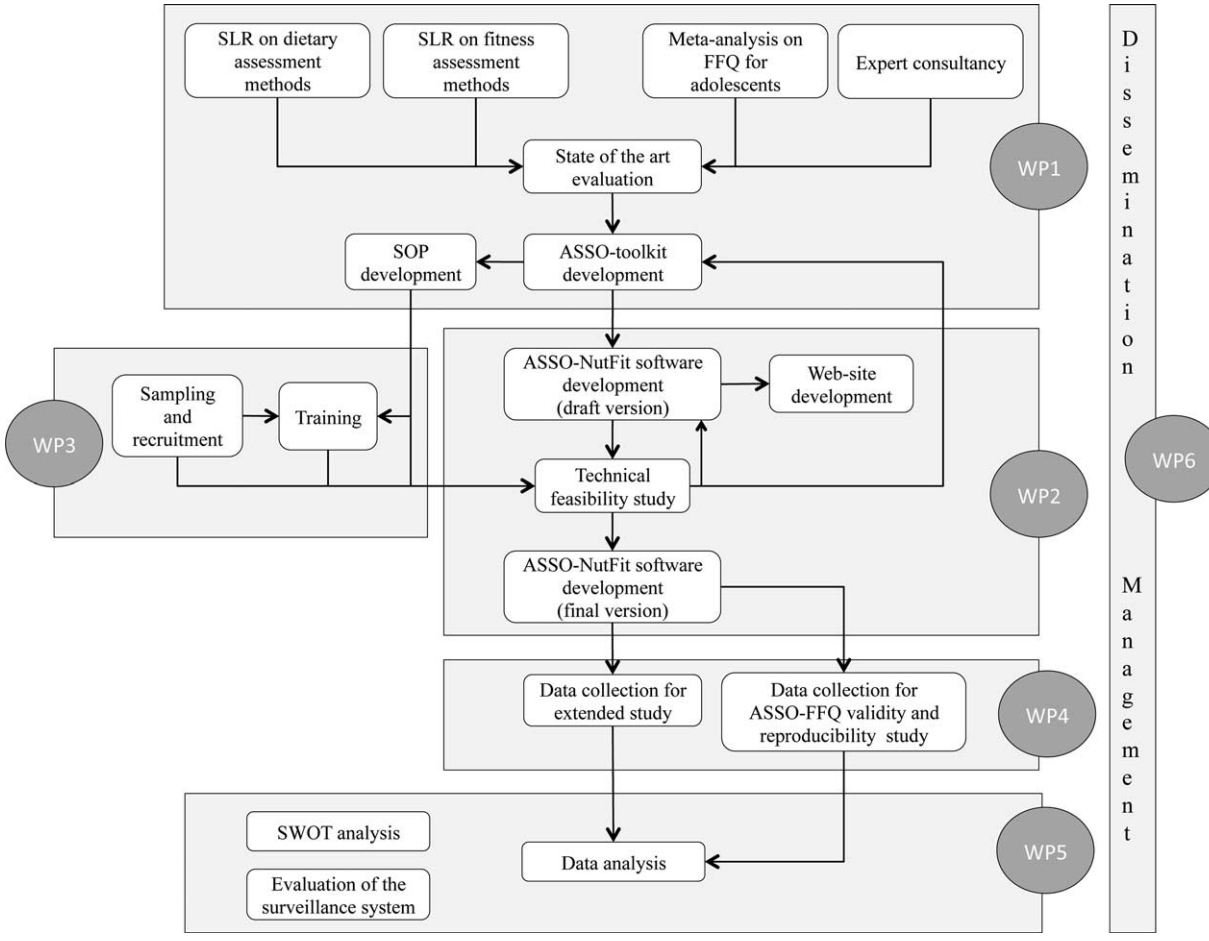

FIGURE 1. Overall structure of the Adolescents and Surveillance System for the Obesity prevention Project (ASSO).

Two reference teachers were selected within each school, one in the scientific area and the other in the physical activity area; their role was to support students in the questionnaire compilation and the collection of the anthropometric and fitness data, respectively.

The ethical approval was given by the ethical committee of the ''Azienda Ospedaliera Universitaria Policlinico Paolo Giaccone'' (approval code n.9/2011).

Schools' Sampling and Students' Recruitment

Public and private high schools of every type (lyceum, technical institute and professional institute) were represented in the study with the aim of including all the socioeconomic levels in Palermo city. A multistage sampling was applied for the schools and subjects' selection (see Supplemental Digital Content 1, http://links.lww.com/MD/A830). Seven secondary schools were recruited, including 1 private and 6 public institutes; the first 4 classes were considered, as in the fifth classes many students 18 years or older were present. A class was considered eligible if the participation rate was at least 85%, and when this rate was not reached, that class was excluded and another class in the same year was chosen in the same school.

All students were provided with an information sheet about the Project and an informed consent to be signed by their parents/guardians. Obtaining the signed consent was the first criteria to consider the subject eligible. The number of obtained signed consents was 919, with a total nonrespondents percentage of 22.8%. The nonrespondents were present in the classes during the data collection, and were briefly surveyed on the reasons of nonparticipation. Most of them (92%) declared that the reason for nonadhering the survey laid on privacy issues, since their parents believed that too much sensitive data should have been provided. A small percentage (6%) was not aware of the reasons why their parents did not sign the consent form, whereas the rest refused to respond.

Disabled students and all those students for whom a proper collection of data was not possible, as well as students younger or older than 14 years, were initially included in the study but not included in the database for data elaboration and analysis.

All sensitive data were protected according to the Italian privacy law n.196/2003. For the registration of participants, an identification code (ie, the fiscal code) was used instead of name and surname.

Training

A 4-hour training session in the afternoon was organized for all the teachers from the selected schools, to standardize methodologies for data collection and well-managed materials and tools. Different PowerPoint presentations and a specially designed web-based tutorial for the compilation of food records were created and shown. A demonstration of the application was shown to teachers on how to access the software, complete the online questionnaires, and include fitness data. The Standard Operating Procedures (SOP) developed by the team and described further in this article, and all needed materials, were distributed to the teachers during the training session.

In a second 4-hour afternoon session, each physical activity teacher participating in the previous session completed reliable measures on approximately 10 volunteer participants and was certified for body composition and fitness measurements. Intraobserver reliability was >95%; interobserver reliability was >90%.[9]

Tools Development

ASSO-toolkit Development

Two systematic literature reviews (SLRs) on the most valid dietary and fitness assessment methods used in the target population[8,10] and a meta-analysis of the validity of food frequency questionnaires targeted to adolescents[11] were performed. The obtained results, that is, the suggestion on the need of a new FFQ and the selection and incorporation of 5 fitness tests in a new battery, together with the consultation of the different involved experts, were useful for the development of the ASSO-toolkit.

As shown in Table 1, the ASSO-toolkit consists of 4 questionnaires (ASSO-Personal Information Questionnaire [ASSO-PIQ];ASSO-Physical Activity, Smoke and Alcohol Questionnaire [ASSO-PASAQ]; ASSO-Food Habits Questionnaire [ASSO-FHQ]; ASSO-Food Frequency Questionnaire [ASSO-FFQ]), one ASSO-Body and Fitness Measures Tool (ASSO-BFMT) including a ASSO-Body and Fitness Measures Form (ASSO-BFMF), and a Fitness Tests Battery (ASSO-FTB), and Standard Operating Procedures (SOPs).

The ASSO-PIQ includes questions regarding participant and family information, neonatal and clinical assessment. The ASSO-PASAQ consists of 3 sections: physical activity, smoking, alcoholic drinks, and other beverages. The ASSO-FHQ consists of 6 items regarding: breakfast, school break, lunch, afternoon break, dinner, and various habits. The ASSO-FFQ is a semiquantitative FFQ, structured in 3 sections (foods, beverages, and supplements) including 20 major groups: 12 food groups (fruit/vegetables/legumes, cereals/bread/substitutes, pasta/rice/couscous, potatoes, sweets, cheeses/yogurt, fishery products, meat, eggs, fats/oils, savoury foods, regional dishes); 7 beverages groups (water, soft drinks, juice/milkshakes, milk, tea, coffee, alcoholic drinks), and 1 supplements group. Each main group was stratified into subgroups, for a total of 106 items. This classification was put together according to the European Food Safety Agency,[12] on the basis of the common nutritional properties. The adopted classification considered the different methods of cooking foods, distinguishing between raw and cooked vegetables, and the different cooking techniques, for example, for potatoes. For every food subgroup, a legend was added that explained what foods/beverages/supplements were included in that group. The consumption frequency was set on 8 different frequencies, and the portion size was assessed through the use of pictures taken by the ASSO team and where necessary household units were used. The use of pictures with different sizes made the portion size estimation much easier and more accurate, and therefore helped the subjects to better evaluate and choose the size closer to their real consumption (the errors reported when these kind of portion size estimation methods are used are sufficiently small, within 5%–10%).[13] A subsection related to the reporting of regional/local products was introduced.

For the compilation of all questionnaires, a total time of 45 min were needed, with the only FFQ taking 20 minutes to be filled in; other developed questionnaires reported a similar or even longer time for compilation.[14–19] All the questionnaires were compiled in the classroom setting, with teachers available to answer possible questions; if the student was not present the day of the data collection, the teacher assigned it to him as a homework, so that a bunch of students filled their questionnaires in home.

The ASSO-BFMT included the description of methods to collect anthropometric measurements, including body weight,

TABLE 1. Tools Included in the ASSO-toolkit

ASSO-toolkit			
Tool	**Sections**	**Duration, min**	**Outcome/Measure/Objective**
ASSO-PIQ	Section A. General information Section B. Family information Section C. Neonatal information Section D. Clinical information	10	General, family, neonatal and clinical information
ASSO-PASAQ	Section A. Physical activity Section B. Smoke Section C. Alcohol	10	Physical activity, smoke and alcohol consumption
ASSO-FHQ	Section A. Breakfast Section B. School recess Section C. Lunch Section D. Afternoon snack Section E. Dinner Section F. Various food habits	5	Meals practices and food habits such as organic products consumption, precooked foods
ASSO-FFQ	Section A. Foods Section B. Beverages Section C. Supplements	20	Foods, beverages and supplements consumptions
ASSO-BFMT		45	
Weight, height, waist circumference		5	BMI, metabolic risk
ASSO-FTB	Hand grip test	3	Maximum isometric strength of hand and forearm muscles
	Standing broad jump test	3	Lower body power
	Sit up test	3	Abdominal muscular endurance
	4×10 m shuttle run test	5	Speed and agility
	20 m shuttle run test	15	Maximal aerobic fitness
ASSO-BFMF			Report anthropometric and fitness measures
SOP	1. General procedure 2. Procedures for the collection of data from questionnaires 3. Procedures for the collection of body measures and fitness test measurements		Standardize methods and procedures

ASSO-BFMF = Adolescents and Surveillance System for the Obesity prevention Project-Body and Fitness Measures Form, ASSO-BFMT = Adolescents and Surveillance System for the Obesity prevention Project-Body and Fitness Measures Tool, ASSO-FFQ = Adolescents and Surveillance System for the Obesity prevention Project-Food Frequency Questionnaire, ASSO-FHQ = Adolescents and Surveillance System for the Obesity prevention Project-Food Habits Questionnaire, ASSO-FTB = Adolescents and Surveillance System for the Obesity prevention Project-Fitness Tests Battery, ASSO-PASAQ = Adolescents and Surveillance System for the Obesity prevention Project-Physical Activity, Smoke and Alcohol Questionnaire, ASSO-PIQ = Adolescents and Surveillance System for the Obesity prevention Project-Personal Information Questionnaire, SOP = standard operating procedures.

height, waist circumference, and to perform the FTB administration. Anthropometric measurements were collected through the use of a weight scale, a stadiometer and a nonelastic meter, all instruments commonly available within the schools and used by the teachers themselves to collect these data during their school curriculum. The ASSO-FTB included 5 tests: Handgrip test; Standing broad jump test; Sit up test to exhaustion; 4×10 m shuttle run test; 20 m shuttle run test (Table 1). They allowed the estimation of upper body maximal strength, lower body maximal strength, abdominal endurance, speed/agility/coordination, and cardiorespiratory endurance respectively. All these tests were easily performed within the school because they require few tools and easy equipment generally available in the school; only the handgrip was provided by the University, as it was not a common tool used within the school environment. A total time of 30 minute per student was needed for the collection of anthropometric measurements and the performance of all fitness tests; some of them could be administered to more students at a time, hence reducing the total time needed for the whole class. The ASSO-BFMF included in the tool was useful for teachers to report on all these measurements, before transferring them to the software.

A total time of 75 minutes was required per student to perform the entire ASSO-toolkit, this being considered a reasonable time to promote the introduction of the ASSO in schools as a continuous surveillance system strategy.

The SOPs included: a general procedure, for the activities preceding the data collection (namely selecting schools, classes, students and teachers and configuring them in the ASSO-NutFit software), training teachers, preparing all the materials and tools necessary for the data collection; procedures for the collection of data from questionnaires; procedures for the collection of anthropometric and fitness test measurements. These procedures were addressed to all ASSO operators and teachers involved in the collection of lifestyle data of adolescents within the schools and provided information on the modalities to: standardize methods and procedures to prevent systematic errors in the data collection and reporting; provide reminders of the correct way to perform a procedure; deal with the information material and tools related to the study; support students in the self-administration of the questionnaires; collecting anthropometric and fitness data; store the collected information.

ASSO-NutFit Software Development

The ASSO-NutFit software was developed with the aim of obtaining an instrument for a web-based collection of data.

Software implementation was done using J2EE (Java 2 Enterprise Edition), using MySQL as database engine with InnoDB configuration type. The software's architecture is shown in Figure 2. Data are inserted by the administrators, teachers, and students, and are registered in the relational MySQL, in a database named ''master,'' which is accessible uniquely by the developed application. Database data are synchronized periodically with those present on a database named ''slave'' through the commercial software Access MySQL converted data from the slave database could be acquired and registered on a Microsoft Access database having an identical structure, which is usable for the statistical elaborations. Some of the tools developed for the ASSO-toolkit were included within the software (ie, the 4 questionnaires and the BFMF). Data gathered in the database are crossed and checked throughout the duration of the data collection.

During data acquisition, 2 types of validations are applied: single data field validation and business function cross-field validation. In the field validation, the platform performs a syntactic validation to check whether the data are valid for the specific field. Once the toolkit has validated the data syntactically, it could then validate the data semantically. Semantic validation checks whether the data conforms to specified business rules. After that, the platform performs a cross-field validation of the relationship between the current field's value and the value of the other fields.

Figure 3A shows a snapshot of the ASSO-NutFit interface with Administrators registering Institutes and teachers from each school. Once teachers are registered, a username and password are automatically sent to them, so they can have access to the software. Teachers from the science area have the role of registering students (Figure 3B), who are automatically provided in their turn with username and password to their E-mail addresses. Students can then have access to the application and compile the questionnaires. Figure 4 provides a snapshot of the interface of the ASSO-FFQ compiled by the students. Other snapshots of the questionnaires' interfaces can be found on the Supplemental Digital Content 2, http://links.lww.com/MD/A830.

Teachers from the motor area have the role of reporting all the anthropometric and fitness data into the study's ASSO form and then transfer them to the ASSO-BFMF on the software.

A website of the project (http://www.assoproject.info) was built up to disseminate the project's contents and allow collaboration between the researchers involved. User data synchronization was maintained between the website and the ASSO-toolkit to send communications to different actors involved (students, teachers).

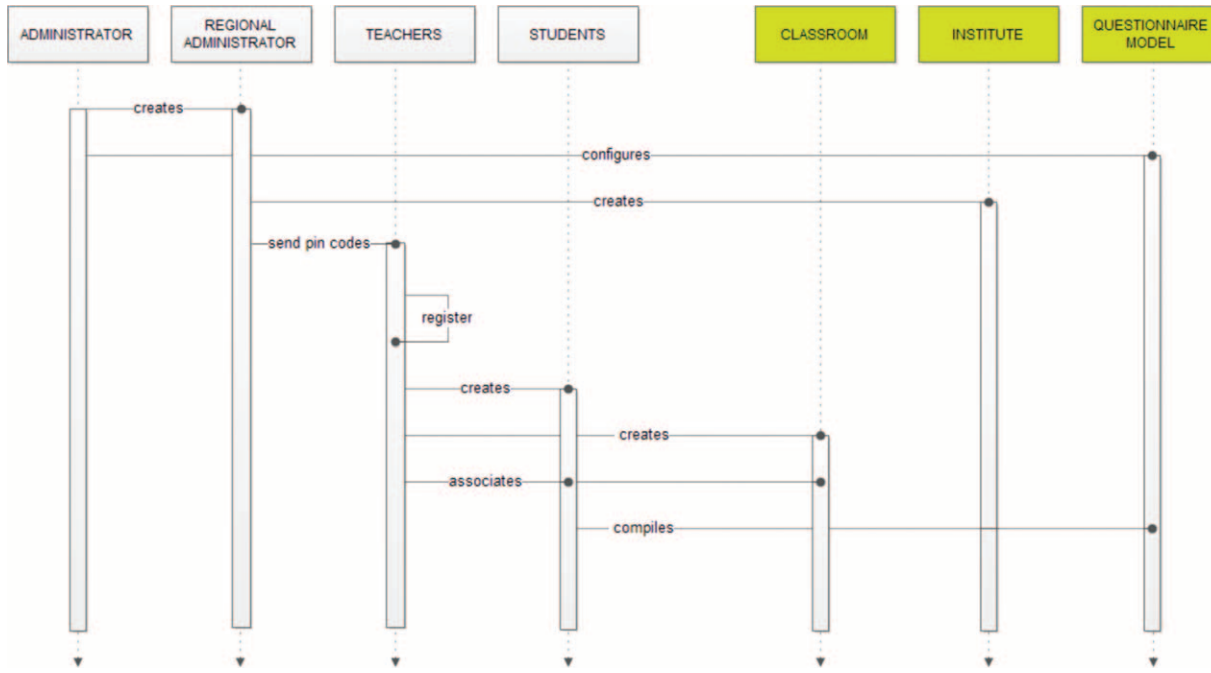

FIGURE 2. The ASSO-NutFit software architecture.

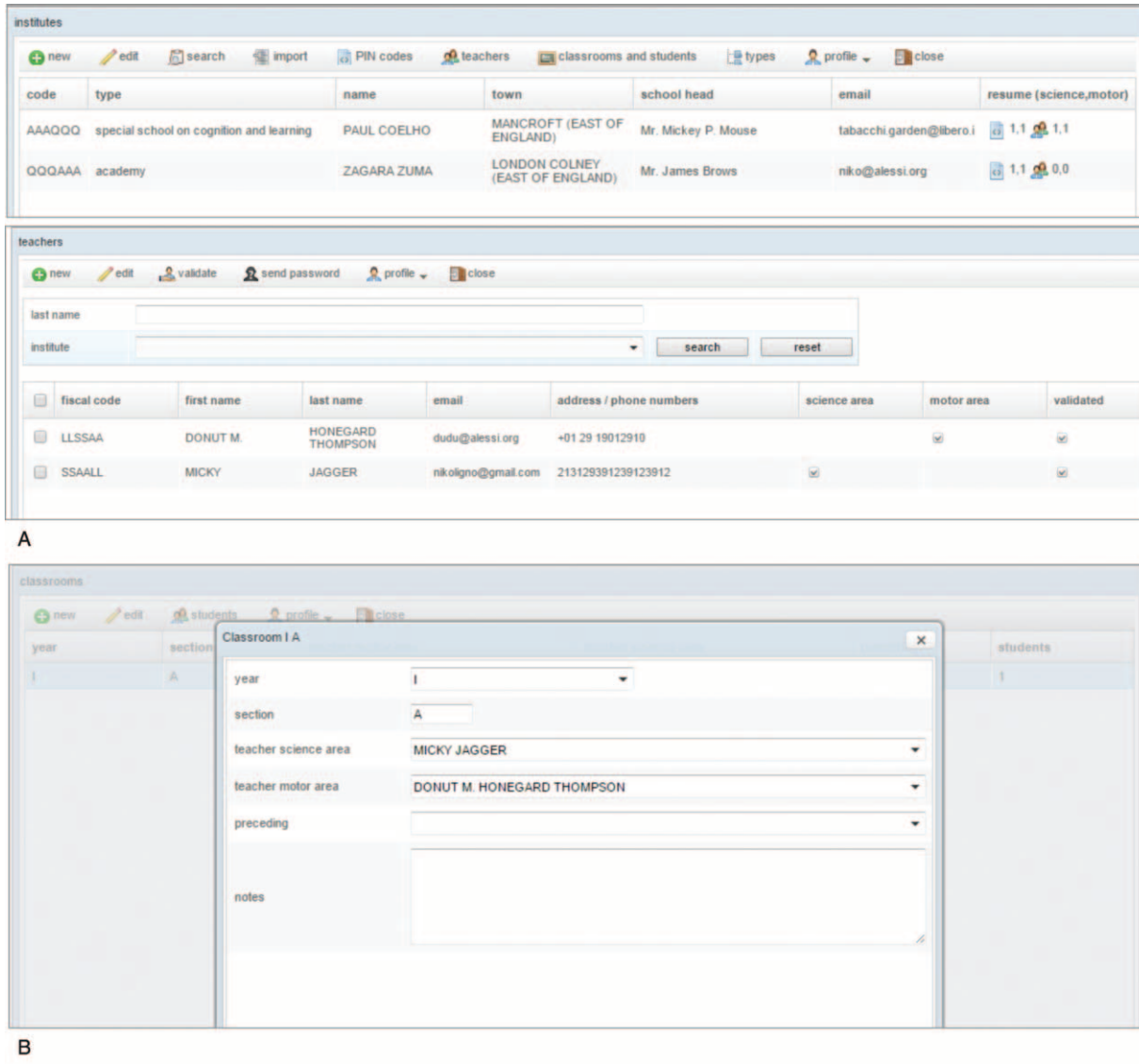

FIGURE 3. Snapshot of the ASSO-NutFit software interface of the Institutes' registration by the administrators (A) and students' registration by the teachers (B).

RESULTS AND DISCUSSION

Implementation

Technical Feasibility Study

At the first stage, data were collected on a subsample of population for a technical feasibility assessment of the ASSO-NutFit software and of the developed procedures. This study allowed testing the applicability of the system before extending it to the total sample of adolescents, providing the ASSO team with the information needed to guide the project's strategy toward achieving objectives, identifying activities and processes that needed amendments.

A sample of 100 boys and girls aged 14 to 17 years was recruited from 3 of the selected high schools in Palermo, including 1 lyceum, 1 technical, and 1 professional institute, to conduct this study in the year 2011 to 2012. This preliminary study highlighted different technical and procedural issues, related both to the developed tools and the software structure, which subsequently led to modification and adaptation of the tools and the application software for a more accurate data collection.

Issues Related to the Developed Tools

In general, the few initially open-ended questions were converted into closed-ended questions. Sometime the questions' structure was changed to obtain a more accurate answer. When numerical answers had to be given, some student provided implausible responses; hence, limited ranges were imposed for the reply in the software's structure. Some terms were not understandable by all students; therefore, they were exchanged with more suitable ones, Alternatively, some legend was introduced.

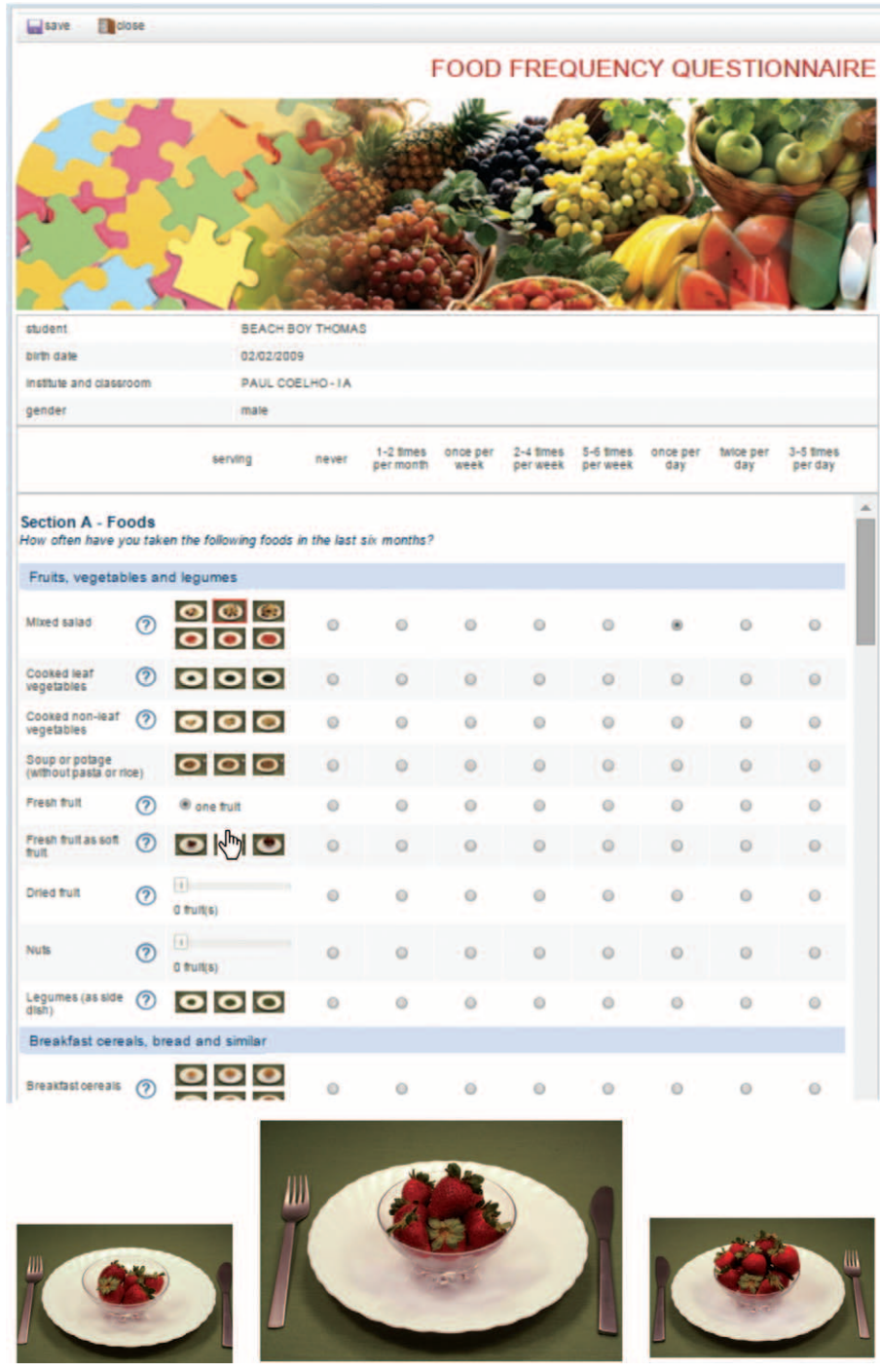

FIGURE 4. Snapshot of the ASSO-NutFit software interface of the ASSO-FFQ compiled by the students.

With regards to the question related to parent's occupation in the ASSO-PIQ, the 9 categories of the ISTAT classification CP2011 (http://cp2011.istat.it/), which were obtained through an adaptation of the International Standard Classification of Occupations, ISCO08, were initially considered. Since they resulted too long and time consuming for the students, a shorter classification was carefully created including only 4 main occupation categories.

The ASSO-FFQ was the most challenging questionnaire. Its first version was too long and time-consuming. A shorter version was then suggested, by slightly modifying the EFSA classification and deleting or incorporating some groups such as the whole pasta/rice/couscous with different types of condiments, which was integrated into a unique group of pasta/rice/couscous.

The quantification of the portion size was identified using units such as ''number'' (eg, number of dried fruits, nuts,

biscuits, candies/chewing gums), that were initially grouped into classes and subsequently substituted by a slider that quantified the exactly amount. The same thing was suggested for the number of bottles of water, soft drinks, and energy drinks.

Cocoa powder intake was not included as subgroup for the sweets group, but the feasibility study evidenced that many adolescents consume this product; therefore, it was added in the main questionnaire. Different students also eat ''crepes'' (pancakes) as sweet; thus, they were introduced as a subgroup in the sweets group. Salted crepes, anyway, together with precooked food and quiches, were also a commonly eaten food in the territory, and therefore included as a subgroup under ''other foods.'' In the first version, cream and béchamel were not included in the fat group, and since many students often consumed these products as condiment for the pasta, this was added to the fat group. The box relative to the extra virgin olive oil was initially divided from the olive oil in this main group, but then the 2 boxes were collapsed.

In the first ASSO-FFQ, there was no question for the assessment of episodes of binge drinking (five or more drinks in a row), a phenomenon that is quite frequent in the adolescence. Thus, a question was introduced to assess eventual episodes of binge drinking.

The classification of supplements was difficult in the first stage, as a wide range of types exist in the market; moreover, a database with all the nutrient components does not exist. It was, therefore, necessary to create such a database and include it within the ASSO-FFQ.

Issues Related to the Developed Software

Other issues were highlighted in the structure of the ASSO-NutFit software. The software architecture was based on J2EE paradigm, using ZK Framework library to enhance user experience and following the same interface interaction as the common desktop applications.

The application was based on a pluggable component and event-driven programming model; therefore, the platform was open to other developers to add functions to respond to events of components that were triggered by user interaction, such as adding supplementary validation procedure, or different input controls.

The use of Hibernate component in the platform architecture was made to maintain isolation from having to know the underlying database; so, it is possible to enhance the platform using a more powerful commercial database engine, to reach desired scalability. Hibernate, in fact, makes use of the database and configuration data to provide persistence services (and persistent objects) to the application.

Validity and Reproducibility Study of the ASSO-FFQ

After all the needed adjustments, the questionnaires were tested on another subsample of the population to check the compliance of participants, and studies on the validity and reproducibility of the ASSO-FFQ were performed.

Validity of the ASSO-FFQ was performed in a small subsample of 92 boys and girls aged 14 to 17 from 3 of the selected schools, after completing both the ASSO-FFQ and a 7-day weighted food record (WFR). A hardcopy of the WFR was distributed to participants on the same day of the ASSO-FFQ administration, to be filled in the week following the ASSO-FFQ compilation. This study suggested that the ASSO-FFQ could be considered as a valid instrument for ranking subjects on a range of food and nutrient intakes.[20]

The ASSO-FFQ was compiled twice by a sample of 185 students for the reproducibility study, who were selected by stratifying per age and type of school. The analysis revealed that the ASSO-FFQ was a reliable instrument for estimating food groups, energy, and nutrients intake in adolescents.[21]

The ASSO-FFQ, therefore, can be used in epidemiological studies on a large scale to obtain valid and reliable estimations over time.

Extended Study

The final versions of the tools, software, and procedures were then realized, and the study was extended to the whole sample population. After cleaning the data, a total of 788 students provided the requested data on their consumptions, lifestyles, and fitness level, which were collated in a general database and are under analysis and elaboration at the moment. From a first elaboration, data are valid, plausible, and clear, and the partial elaboration made them suitable for a fast statistical analysis. No issues arose from the high number of data collected (eg, server capacity). The time used for the data collection was acceptable (75 minutes for each student) and satisfaction of students and teachers was accomplished.

Evaluation

An ASSO Project evaluation was completed according to a SWOT analysis to identify strengths, weaknesses, opportunities, and threats,[22] and according to the guidelines provided by the CDC.[4] This evaluation was performed by the ASSO staff members involved in the design and management of the Project and other staff members, such as teachers selected within the schools. The results are listed in Figure 5.

The ASSO system is focused on a disease that is considered an emergent public health issue, of public interest, and highly preventable; as the public health importance of health-related events are influenced by their level of preventability,[4] the system should be considered a priority for the National Health System (NHS). The obese adolescent will most likely become an obese adult[23,24]; therefore, it is important to monitor their trends to implement appropriate preventive actions. Moreover, the possibility of easily adapting this system to younger populations of schoolchildren can shift the prevention to that age as well, thus making the system even more efficient. The health costs related to obesity would be reduced, as well as eventual inequities related to the access to public health cares.

The establishment of a highly standardized methodology with SOPs in ASSO allows all the involved operators to perform their activities following precise indications that guarantee a high quality, validity, and reproducibility of collected data. ASSO helps identifying risk indicators and correctly addressing overweight/obesity in adolescents; eg, data collected on health and obesity determinants have been used to determine a combined effect of the sociodemographic variables, early factors and lifestyles and identify different patterns and groups of young people more at risk that should be prioritized in interventions (submitted for publication). The system provides accurate data on food consumptions, by using a validated and reproducible FFQ; it correctly estimates food habits and lifestyles, as all the questionnaires used for their assessment have been developed following high standards and expert consultations. It helps identifying disease symptoms that could be predictor of future diseases in adolescents, through a

FIGURE 5. Results of the strengths, weaknesses, opportunities, and threats (SWOT) analysis of the ASSO Project.

properly performed and validated malaise index estimated in a subsection of the PIQ; these data have been used to develop an index of malaise a score for classifying adolescents in different malaise-level categories (submitted for publication). It collects anthropometric measure directly, thus providing accurate estimates of the obesity status in the adolescent population, as well as their overall health and nutritional status; thus, the system can be considered very sensitive. It correctly and completely estimates fitness levels of adolescent, by the application of a test battery accurately selected and validated through the support of national and international expertise; these data were useful to develop a fitness score to categorize adolescents in fitness levels.[25] The system also would allow the identification of trends over time, leading to improved behavioral practices and stimulating research on the prevention and control of obesity.

The web-based technology allows the selection of wider samples; the lower costs of personnel, travelling, materials; the direct and automatic check for missing and incoherent data; the possibility of rapidly compiling questionnaires through easy access also from home; the partial elaboration of data (means and percentages are automatically estimated; BMI and weight status are automatically calculated, as well as other variables such as family affluence scale, etc), thus accelerating data analysis; and the possibility of multilanguage, that provides the potential to be extended abroad, to deliver a complete framework with the possibility of regional comparisons for information on adolescent lifestyles. A characteristic of the ASSO, in fact, is its flexibility, that allows modifying fewer components to adapting the system to other realities. Moreover, it is based on electronic data that could easily be integrated with other existing systems.

ASSO could be considered in general as an acceptable system according to: the satisfactory subjects' participation rate with low refusals; the completeness of the obtained questionnaires; the timeliness of data reporting. It has been observed that students acquired more awareness on the quality and quantity of their consumed food and on their fitness abilities.

Another advantage of the system is that beyond the on-site sessions, the staff training could be performed also on-line through a web-based procedure that uses the developed SOP and interactive tutorials.

The web-based system, moreover, was designed to be available for all schools and superadministered by a leading institution, which provides directions to the other administrators in the regional focal points. The flow chart of the system

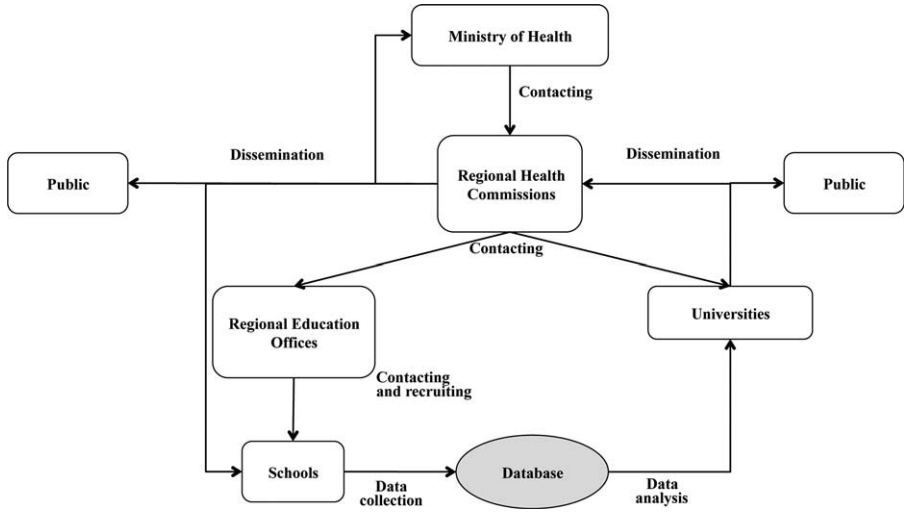

FIGURE 6. Flow chart of the possible interrelations between the Institutions involved in the surveillance system proposed by the Adolescents and Surveillance System for the Obesity prevention Project (ASSO).

proposed in the Italian territory is shown in Figure 6. As it can be evinced, a network between Ministry of Health/Regional Health Commissions, Universities and Regional Education Offices was established, that could contribute in a synergic way in achieving the objectives.

As previously mentioned, the other national surveillance system on adolescent lifestyles in the Italian territory is the article-based HBSC system carried out by the Regional Health Commissions as well. An effort should be made to integrate these 2 systems, through a dialogue and an evaluation of all the different and common characteristics and related critical issues. This could prevent duplication of efforts and lack of standardization that can arise from parallel analogous systems.[26] For example, the ASSO system first of all could provide web-based data, that, compared with HBSC article-based data, are easier to be managed and analysed and allow saving of human and economical resources; it can integrate the HBSC lack of validated and reproducible data on food consumptions; it can provide measured anthropometric parameters on adolescents, which are missing at the moment; it is the first system providing fitness data of adolescents.

The ASSO system can be considered also quite representative, even though some considerations have to be made. Data collected within ASSO are also used to identify groups at high risk and to target and evaluate interventions; sometime, these data collection could lead to different results when sex is considered; e.g. females estimate their food intake better than males, thus the ASSO-FFQ is more valid for assessing food and nutrient intake in females rather than in males, and this could lead to misleading conclusions about the risk factors associated to obesity. This situation can be solved by introducing correction factors when analyzing the data.

Moreover, the sample collected so far is not representative of the entire Italian population, so a study extended to the territory is needed to evaluate the system as a whole.

As ASSO is a web-based system, it relies on the availability and access to an Internet connection and on the stability of the server. On one hand, this could delay the time for collecting data: e.g. in the day established for questionnaire compilation in the school (or at home) an outage of the server may occur; computers in the school could break down and need time for repairing; when exporting data for the analysis the server could be unavailable. On the other hand, the system could be considered stable since it is able to collect, manage, and provide data properly without failure for most of the time needed.

Some limitations of the system consist of the need of parents' advices when compiling the questionnaire's part related to the neonatal evaluation and the weight and height of parents that are reported. Furthermore, students often lose or forget their password and username to access their own email address, or they forget to write the password that is automatically sent by the system to access the application.

Specific threats were identified, such as the possibility that some schools do not have computers or internet connection, or some students do not have computer or internet connection at home. Moreover, issues related to the school staff collaboration were identified, as well as the handgrip instruments that are not sometime affordable by the schools.

One issue was also found on the nutrient composition databases that are often limited and different from one country to another.

An important issue to be solved is the financial resources used for sustaining the implementation and maintenance of the proposed system at national level. An accurate estimation of the national health expenses in this field should be conducted. Unfortunately, this estimation is very complex, but some data exist related to Europe. Studies in the WHO European Region indicate that the direct health care costs of obesity account for 2% to 4% of national health expenditure,[27] which include the direct costs of health services, the indirect costs associated with lost economic production, and individual costs, such as the purchase of slimming products. Among the direct costs, a great part of them is owing to the treatment of cardiovascular diseases, hypertension, and type II diabetes. These high costs associated with obesity and unhealthy lifestyles demonstrate that savings may result from health promotion and prevention, at least in the short term; even though the long-term health savings are not known, obesity prevention programs will almost certainly lead to both short- and long-term gains in economic productivity.[28] Hence, it is hypothetical that the costs of maintaining a surveillance system on obesity and lifestyles could be

sustainable. These costs would be referred to the costs within the Institutions involved (Ministry of Health, Regional Health Commissions, Regional Education Offices, and the University), related to: personnel, that includes the time to operate the system, such as contacting Institutions, editing and analyzing data, and disseminating data; computer and other equipment (software for statistical analysis), telephone, mailing and media; server where data are stored; printed material for dissemination. As the system is web-based, there are no costs of travelling and collecting data.

Nevertheless, a quantitative analysis of the costs should be done after applying the system at a national level.

CONCLUSIONS

The present study provides a detailed overview of the ASSO Project's design and implementation and describes the results of its evaluation process as a local surveillance system.

Such a system is consistent with the country needs and priorities and allows the collection of valid and reliable data on adolescents' obesity, food consumptions, lifestyles, physical activity and fitness levels; it is quite easy and fast to use and well-accepted by the users. Its standardized methodology makes it reproducible in different realities.

Even though few weak points and threats were identified, they do not likely undermine the basic objectives and feasibility of the system. The strengths and opportunities emerged suggested that the ASSO system was valid and effective at the local level.

A scale-up of the system is needed to test the feasibility on the whole territory, and confirm whether it could be adopted within the National Health Service representing a permanent source of high-quality and standardized data to help identify risk factors and implement appropriate preventive actions. The application of such a surveillance system on a large scale could have a significant impact on the national public health service. The result would be an improvement of the efficacy and the quality of the surveillance and prevention in the field of nutrition and physical activity at a national level. Obesity and chronic disease policies and interventions can be translated into a decrease in the burden of disease, thus improving population health and reducing economical public expenses.

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