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OBESITY TECHNOLOGY

Obesity Reduction and Awareness and Screening of Noncommunicable Diseases through Group Education in Children and Adolescents (ORANGE): Methodology Paper (ORANGE-1)

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Abstract

Aim:

Our goal is to estimate the prevalence of obesity, glucose intolerance, hypertension, dyslipidemia, and metabolic syndrome among urban children and adolescents aged 6–19 years and to raise awareness about noncommunicable diseases (NCDs) among school children in Chennai, South India.

Methods:

The Obesity Reduction and Awareness and Screening of Noncommunicable Diseases through Group Education project plans to reach out to children and adolescents using two approaches: the school and the community approach. The school approach aims to reach out to a representative sample of approximately 20,000 urban school children and adolescents, aged 6–19 years, covering 50 schools from all parts of Chennai. Anthropometric measures will include height, weight, waist, body fat, and blood pressure. Data on demographics, family profile, behavioral aspects, physical activity, and food pattern will be obtained by using a validated questionnaire. Awareness about metabolic NCDs like obesity and diabetes will be increased by educating the children and adolescents about healthy lifestyles. Through the community approach, 2000 children and adolescents from randomly selected residential colonies in Chennai will be screened for obesity, glucose intolerance, hypertension, dyslipidemia, and metabolic syndrome.

Expected Outcomes:

Awareness about NCDs will be increased among children and their parents in Chennai. This study will also provide valuable epidemiological data on obesity, glucose intolerance, dyslipidemia, hypertension and metabolic syndrome in children and adolescents in urban India.

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Abbreviations: (BMI) body mass index, (HPS) health-promoting school, (NCD) noncommunicable disease, (ORANGE) Obesity Reduction and Awareness and Screening of Noncommunicable Diseases through Group Education, (WHO) World Health Organization

Keywords: awareness, early onset type 2 diabetes, childhood diabetes, metabolic syndrome, noncommunicable diseases, obesity, school

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Introduction

India is currently passing through an epidemiological transition due to rapid urbanization coupled with economic growth.[1] This could have major implications on the present and future disease patterns in India, with particular reference to an increase in prevalence of noncommunicable diseases (NCDs) like obesity, diabetes, and coronary artery disease.[2–7] Currently, 51 million Indians are estimated to have diabetes, and this number is predicted to increase to 87 million by 2030.[4,8]

There is great concern about the global increase in the prevalence of obesity, especially in children and adolescents.[9,10] The obesity epidemic is closely linked to lifestyle factors such as unhealthy eating habits and decreased physical activity, both of which are occurring largely because of urbanization and globalization. The latter leads to "sedentarism," with a reduction in energy expenditure along with an increase in energy intake. Reasons for this are many: lack of playing area; increased television watching/video games; increased purchasing power; unavailability of healthier food options, particularly in canteens; and the influence of the media and advertisements promoting junk foods. In addition, there is a lack of awareness among parents about healthy eating options, and their busy work schedules force them to opt for convenience foods, thus they are unable to pay attention to their child's diet. What is more disturbing is that the prevalence of overweight and obesity in children and adolescents in developing countries like India is also showing an increasing trend.[11–13] This is a serious challenge, because malnutrition and stunted growth often coexist, and there is thus a double burden of underweight and overweight among Indian children and adolescents.[14] The prevalence of obesity in 5- to 12-year-old children in New Delhi, India, increased from 16% to 24% between 2002 to 2007,[15] while the overall prevalence of overweight/obesity in urban children in New Delhi increased from 16% in 2002 to 24% in 2006–2007.[16] In Chennai, the prevalence of obesity was found to be 18% in boys and 16% in girls.[17] Childhood obesity is a forerunner of obesity in adulthood, which in turn has a strong association with NCDs such as type 2 diabetes and cardiovascular disease.[18,19]

Unfortunately, most of the earlier studies in children and adolescents have been done either on small numbers or in selected schools in India. There is very little data on a representative population of children and adolescents of a whole city, and hence prevalence rates of obesity and glucose intolerance are not available in children. Hence, the authors have planned to undertake a large scale screening of children to obtain accurate prevalence estimates of childhood obesity and glucose intolerance in children and adolescents. This will be supplemented by a massive awareness program among children and adolescents to increase the awareness about NCDs, particularly in urban India. This forms the basis of the Obesity Reduction and Awareness and Screening of Noncommunicable diseases through Group Education in Children and Adolescents (ORANGE) project being undertaken in Chennai. This article details the study design and methodology adopted for the ORANGE project.

Study Design

The ORANGE project is planned as a cross-sectional field survey that will measure the prevalence of obesity in the schools and the community. Hence, the study has two components, namely:

A. school component

B. community (colony) component

School Component

Specific objectives of the school component are to:

- collect anthropometric data of school-going children ranging in age from 6 to 19 years to develop standardized age-specific cut points for height, weight, waist circumference, body mass index (BMI), body fat percentage, and blood pressure in children and adolescents, as such data is not available in India;
- study the prevalence of over- and undernutrition in school-going children from private and government schools; and
- promote the concept of health-promoting schools (HPS) in Chennai.

The sampling for the school component was as follows: The total number of schools listed under the Directorate of Education, Chennai, was obtained first. This list was downloaded from their Web site and cross verified with the official document available in the Directorate Office. These schools were categorized by zone. Chennai is composed of 10 zones. Schools in Tamil Nadu have also been divided into four major categories, namely, primary (age 6–10 years), upper primary or middle school (age 6–13 years), secondary (age 6–15 years), and

upper secondary (age 6–17 years); see http://www.tn.gov.in/schooleducation/statistics/picture1-edn.htm.

The final number of schools sampled was determined to ensure representation from both the geographical area as well as the socioeconomic status of the population. The children and adolescents studying in the government and government-aided schools were categorized as group 1, and they belonged to the lower and lower–middle socioeconomic status, because education in these schools is either at minimal cost or free. In contrast, the cost of education in private or management-run schools is high, and children in these schools were categorized as group 2 and typically belong to the middle and upper socioeconomic groups.

In the second stage of the school sampling, a "standard" (class or grade) was considered as the primary sampling unit for each school selected. From each school, three or four standards were selected, depending on the class strength. All students in the selected class or grade were included in the study. This methodology is similar to another study reporting the prevalence of childhood obesity in schools of Northern India.[20] Following a brief presentation about the study, a written consent was sought from the school authorities to conduct the ORANGE study in their school premises. All consent forms were sent home with the children on the previous day to obtain their parents' signatures, and only children who brought back the signed consent form were screened on the day of the camp.

Community (Colony) Component

The specific objectives of the community component are to:

- study the prevalence of obesity, glucose intolerance, and metabolic syndrome in a representative sample of children and adolescents ranging in age from 6–19 years in Chennai;
- develop a risk score that will help to identify diabetes/prediabetes in children and adolescents; and
- create awareness about NCDs among the children, adolescents, and their family members.

The sampling for the colony component was carried out using the following method: The list of zones and the areas under each corporation zone was obtained from the Corporation of Chennai Web site, and the residential colonies were randomly selected from the areas covered under each zone, ensuring that the colonies selected were representative of Chennai. Permission was obtained from the Colony Welfare Association president and secretary of every colony before conducting the screening and awareness. A brief presentation was made to the colony authorities explaining the need for the study. Every family in the colony was approached, and the children who fit the age criteria were included in the study only after obtaining the informed consent of the parent and the assent of the child.

The study was conducted according to the ethical guidelines laid down by the Indian Council of Medical Research, and the study was approved by the Institutional Ethics Committee of the Madras Diabetes Research Foundation.

Sample Size Calculation

Among Chennai school children, the reported prevalence of overweight and obesity is approximately 6%.[9,21] Because both studies were done 6–7 years earlier, we hypothesized that the prevalence would be higher. Thus, assuming a current prevalence estimate of 10%, a sample size of 1014 children was required, with 80% power, 95% confidence intervals, and an estimated 3% margin of error. Considering a drop out rate of 10%, a sample size of 1115 was determined. However, as no epidemiological data on prevalence of glucose intolerance among children and adolescents were available in India, we decided to oversample, and thus a final sample size of 2000 was considered for the community component.

However, in the school component, the primary objective was to develop cut points for obesity and normative data for various parameters such as height, weight, waist circumference, body fat percentage, and blood pressure using the data collected. Because the study covers a wide age range from 6 to 19 years, in order to ensure sufficient numbers in each age group (total of 14 age groups), a large sample size was considered that would help develop accurate age-specific cut points. A sample size of 20,000 was determined—in order to obtain a sufficient number of children representing both genders in each age group—for which at least 400 children per school from a minimum of 50 schools would have to be screened.

Phases of the Study

The ORANGE project was planned as follows. (See **Figures 1** and **2** for the project flow.)

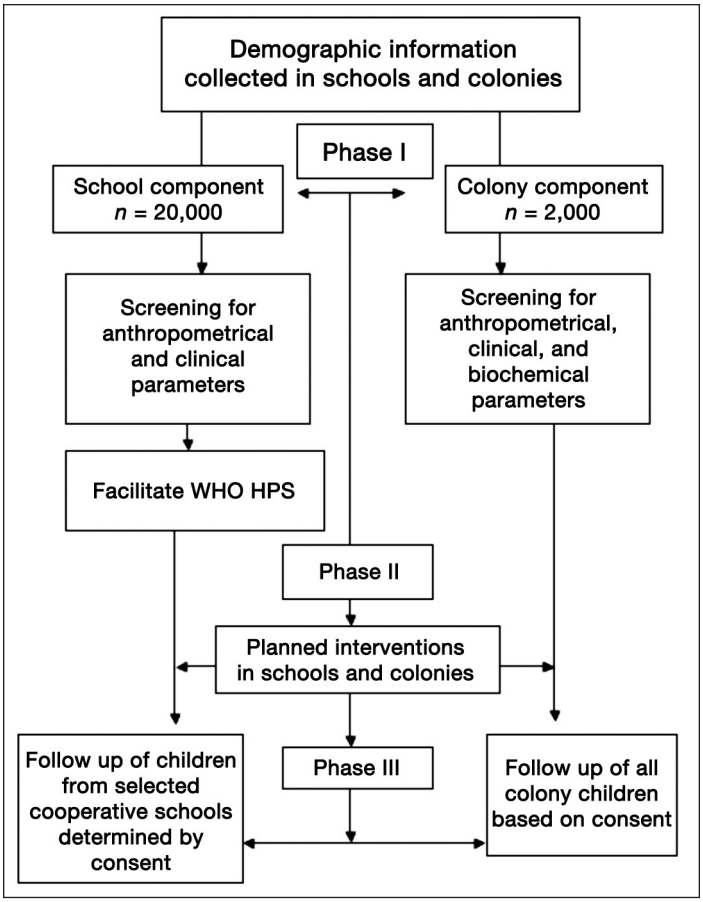

Figure 1. The ORANGE project flow chart.

Phase I of the Study: Pilot Phase

Initially, a pilot study was conducted among the subjects in schools and colonies to identify inadequacies and omissions in the questionnaire and to determine the time duration of screening the subjects in schools and colonies and practical difficulties of drawing blood samples from children. This phase included training the study team, liaising with the government authorities, and finally administering questionnaires and obtaining blood samples from the children.

Three self-administered questionnaires were developed during the pilot phase and used in the study, namely, the child questionnaire, the parent questionnaire, and the teacher questionnaire. The child questionnaire was adapted from the SEARCH for Diabetes in Youth proforma (*http://www.searchfordiabetes.org/public/provider/forms.cfm*) and included details regarding the subject's demographic profile, knowledge about NCDs, daily physical activity and diet pattern, and impact of advertisements and cartoons on food choices. A test sheet was attached at the end of each child questionnaire, which detailed the anthropometric measurements, blood pressure, pulse, age of menarche (only for girls), biochemical test values, and clinical markers of insulin resistance and obesity. The parent questionnaire also adapted from the SEARCH parent questionnaire was used to obtain information such as family profile, income, educational qualification, physical activity and diet pattern, family history of diseases, frequency of fast food consumption, sedentary hours, knowledge about diabetes and obesity, and frequency of eating out, especially "fast" food. The teacher questionnaire included information regarding the importance of physical activity and other extra-curricular activities, food served in the canteen, nutrition education provided in the school, knowledge about obesity, and whether the school meets the criteria to be classified as a HPS.

The pilot study helped clear ambiguity in the questionnaires and revealed a good response rate from the study subjects in both components of the study (92% in schools and 100% in colonies), which provided the confidence to proceed further. All three questionnaires were used in the school component whereas only the child and parent questionnaires were used in the colony component.

The pilot study also revealed that, in schools, blood testing for large groups was not practical, as the children did not come fasting for the blood glucose testing. Moreover, at school, it was difficult to prevent the children from eating something before the second blood was drawn at 120 minutes. To overcome this problem, blood tests were planned only for the community component, where blood testing was done at the homes of the children under parental supervision and monitoring of the child over a 2 h period was also feasible.

Phase II of the Study

Training the Study Staff

Health educators, social workers, field investigators, and laboratory technicians were trained on the administration of questionnaires and taking of anthropometric measurements such as height, weight, and waist circumference. The trainees were educated to use the electronic machine to measure blood pressure and pulse and the body impedance analyzer to measure body fat. The laboratory technicians were trained to take venous blood samples from the subjects by Vacutainer method. The trainees were considered fit to conduct the study only if they achieved minimum error rates for all the measurements based on an examination conducted for them, including a practical examination.

Quality Control

The equipment used for the study, including the digital weighing machines, stadiometers, measuring tape, body fat analyzer, and electronic blood pressure apparatus, were calibrated before every camp. The digital weighing machine was calibrated against "known" weights, and the stadiometer was calibrated against a nonstretchable measuring tape. A similar procedure was followed for

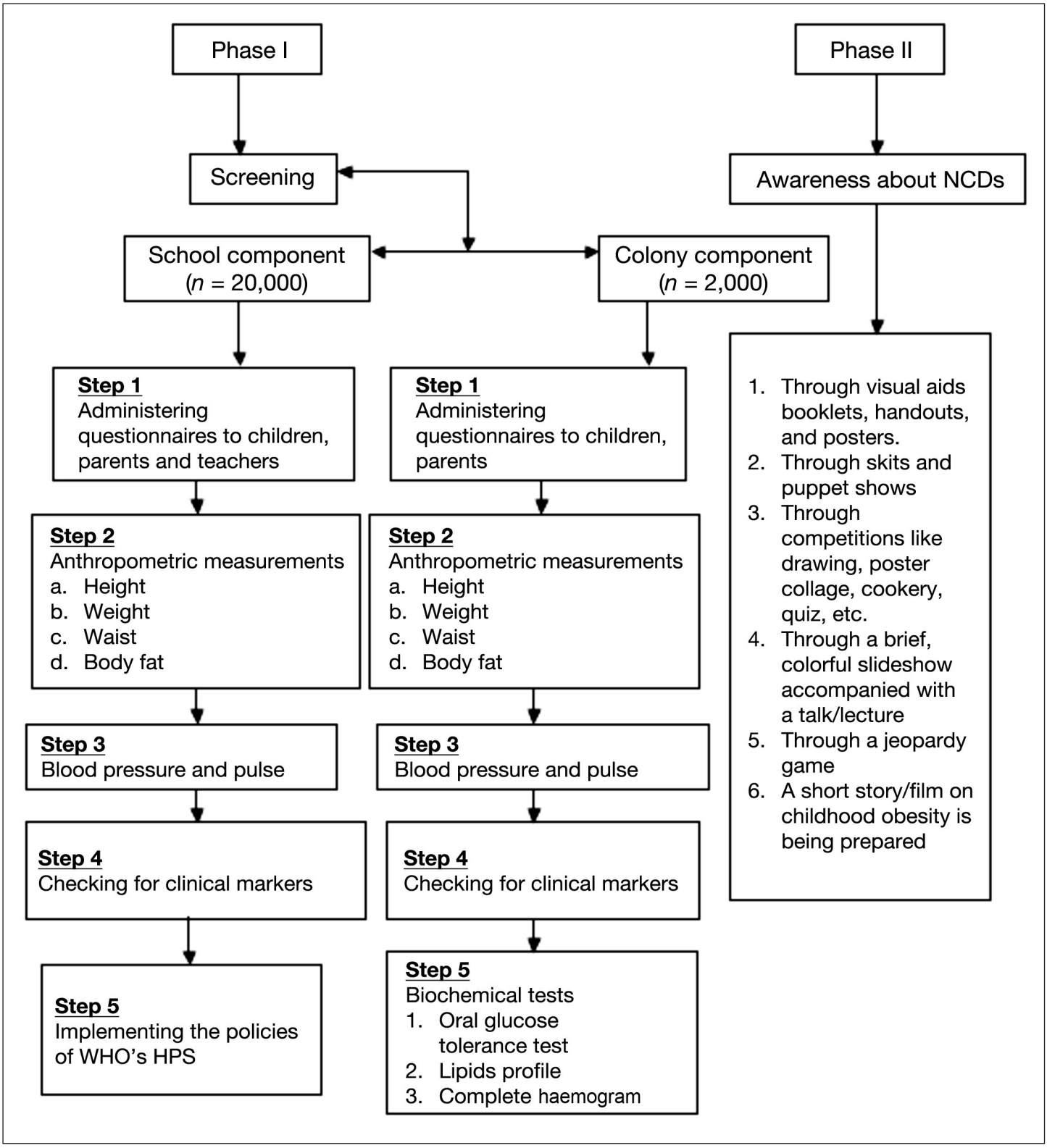

Figure 2. The ORANGE project, phases I and II.

the electronic blood pressure machines and body fat analyzer, which is calibrated against another machine. The machines were used for the study only if the coefficient of variation was <5%. The field staff was frequently monitored as to how they explained the consent form and questionnaire to the subjects. Quality checking of the data entered was carried out regularly.

Study Procedure

The following steps were involved in conducting the study.

Questionnaire administration

In the schools, the questionnaire administration was done by class. It took approximately 20 minutes to complete the questionnaire and 10 minutes to take anthropometric measurements. The parent questionnaires were sent home with the subjects and collected the next day. The teacher questionnaire was administered to a minimum of three teachers per school, namely, (a) the school head (principal/ head master), (b) the physical director or physical training teacher, and (c) the coordinator for extracurricular activities. These specific categories of teachers were selected, as they could give details on school policies regarding health and hygiene.

In the colonies, the first step was to obtain a brief demographic profile about the family, including family history of diabetes, 2–3 days prior to the day of testing. The parents were informed that the child should come after at least 10 hours of overnight fasting before performing the test. Phone calls were made before the day of testing, and parents were briefly informed about the blood tests and other measurements to be taken on the day of testing.

On the day of testing, informed consent was obtained from parents of children less than 18 years of age along with the child's assent, and for all subjects above 18 years of age, consent was obtained from the subjects themselves and the questionnaires were administered.

Anthropometric measurements

Next, anthropometric and blood pressure measurements were taken in all study subjects.

Height

Height was measured in centimeters using a stadiometer. Subjects were asked to stand upright without shoes with their back against the scale, heels together, and eyes directed forward. With the help of the headrest, height was measured to the nearest centimeter.

Weight

Weight was measured in kilograms using a weighing machine that was kept on a firm horizontal surface. The scale was checked every week, and calibration was done with known weight.

Body fat percentage

Body fat percentage was measured using the body impedance analyzer, which is a standardized machine used to measure body fat. For children below 10 years of age, body fat was not measured. Subjects were asked to wear light clothing and requested to set aside any heavy items such as mobile phones or keys before recording their weight and body fat.

Body mass index

Subject BMI was calculated using the formula weight (kg)/height (m^2).

Waist

Waist was measured in centimeters using a nonstretchable fiber measure tape. The participants were asked to stand erect in a relaxed position with both feet together. One layer of clothing was accepted. Waist girth was measured as the smallest horizontal girth between the coastal margins and the iliac crests at minimal respiration.

Blood pressure

Blood pressure was recorded in the sitting position in the left arm to the nearest 1 mmHg using the electronic OMRON machine (Omron Corporation Tokyo, Japan). Two readings were taken 5 minutes apart, and the average of the two was taken as the blood pressure. Pulse readings were also noted from the electronic OMRON machine.

Biochemical testing

As part of the community component in the colonies, an oral glucose tolerance tests was carried out for the children and adolescents. Fasting venous blood samples were drawn from the subjects between 7:00 and 8:00 AM, followed by questionnaire administration to the subjects and their parents and collection of anthropometric and blood pressure measurements. The whole procedure took 2 hours to complete.

After the blood samples were drawn, the tubes were kept in an icebox to prevent blood lyses. Stored blood samples were centrifuged at 3000 Rpm. Fluoride and ethylenediaminetetraacetate were used as anticoagulants for storing blood samples. Serum was stored at –20 °C while whole blood was stored at –80 °C. The following

tests were performed among the colony subjects: fasting plasma glucose, 2 hour post glucose (hexokinase method), serum total cholesterol (CHOD-PAP method), high-density and low-density lipoprotein (direct method), cholesterol, serum triglycerides (GOP-PAP method), serum fasting insulin concentration was estimated using kits supplied by Roche Diagnostics (Nannhem, Germany), and a complete hemogram was estimated using a Sysmex XT 1800 i analyzer (Kobe, Japan). The glucose load to be given was calculated as follows:

For children <12 years of age, glucose load in grams = body weight (kg) × 1.75.

For subjects above 12 years of age, 75 g of glucose was given.

All subjects were examined for the following *clinical markers* of insulin resistance and obesity with the help of a physician: acanthosis nigricans, double chin, hirusitism (in female subjects), and skin tags.

The questionnaires were thoroughly checked for completion, and then data were entered in the software. Ten percent of data entered was rechecked for quality by the double data entry method.

Phase III of the Study

Campaign on Awareness about Noncommunicable Diseases

An educational program to increase awareness of obesity, diabetes, and other NCDs among children and adolescents was implemented that would help them change their lifestyle behavior and thus help evolve effective preventive strategies. Awareness on NCDs to reduce obesity, diabetes, and hypertension was implemented through an integrated behavior change communication plan in both English and regional language (Tamil). The project is expected to reach out to 22,000 children and adolescents to increase awareness about obesity and other NCDs by developing and disseminating educational tools and other resources to promote and improve the quality of life. The project will target at least 100,000 people through the children and adolescents, assuming that approximately four or five members in each family are reached through one subject. In addition, there are plans to reach out to the community directly by organizing intervention programs at the colony level, which are not detailed in this article, as the programs are in the planning stage. The awareness building and empowerment will include the following:

Developing educational materials

Low-cost educational material, visual aids, pamphlets, posters, flip charts, educational labels, health-based jingles, health cards, an NCDs prevention booklet (in English and the regional language, Tamil) and CDs (in English and Tamil) were some of the approaches used to impart knowledge to children and adolescents. Besides these, quiz, skit, game show, cookery, collage, drawing ,and poster competitions were organized in the schools and colonies to encourage children and adolescents to adopt and practice healthy lifestyles.

Awareness programs

Some of the messages that were highlighted in the awareness programs through lectures, audio–visual aids, skits, and posters included the following:

- What are NCDs?
- Health implications of undernutrition, obesity, and diabetes among children and adults
- Importance of increased physical activity and reduced television viewing
- Importance of weight reduction
- Importance of following a traditional diet pattern and healthy eating
- Understanding the fast food culture and how to reduce consumption of fast foods
- Increasing fruit and vegetable consumption
- The need to cut down on calorie, fat, and sugar intake wherever appropriate
- Ill effects of smoking, use of smokeless tobacco, alcohol, etc.
- Spotting the hidden messages in junk food advertisements
- The need to understand food labeling

Health promoting schools, a World Health Organization initiative

Health promotion is defined by the World Health Organization (WHO) as "the process of enabling people to increase control over and to improve their health."[22] According to the WHO, various approaches to practicing health promotion are issue based, population based, and setting based.

This project combines all three approaches. The central issue is obesity and increasing NCD awareness, the population is children, and the setting is the school. This study thus maximizes the outreach of HPS by combining all three approaches. As part of the program, simple questionnaires were given to the school authorities to assess their awareness and the importance given to health education in their schools. Health facilities available at the school, such as a canteen supplying nutritious food, playground space, and physical activity hours, are assessed, and a complete report on what is lacking and what activities the school needs to carry out in order to be called a HPS school are given to them during the program. A follow-up is planned to note the progress of the schools in implementing the suggestions made and to analyze the impact of the program.

Intervention program

Studies have shown that changes in BMI during childhood and adolescence are seen as a potent predictor of adult obesity,[23] hence it becomes imperative to plan prevention and intervention programs that target these age groups. Various intervention programs to combat childhood obesity in school children have been reported from other countries.[24,25] However, such programs are lacking in India. An intervention study from northern India done in school children is one of the preliminary studies reported, and it has shown that, through well-planned intervention programs, the knowledge and behavior of school children toward healthy habits can be improved.[26] Thus comprehensive sustainable intervention programs aimed at improving the health of the children, parents, and teachers as a community is needed. The intervention and evaluation component of the ORANGE study is still in its planning stage and hence not detailed in this article.

Conclusions

The ORANGE project is one of the largest systematic population-based studies on obesity, glucose intolerance, dyslipidemia, and metabolic syndrome conducted among children and adolescents in India. Once completed, this study is expected to reveal data on prevalence of obesity, undiagnosed diabetes/prediabetes, dyslipidemia, and metabolic syndrome in urban children and adolescents and aid in developing appropriate cut points for different obesity parameters that are currently unavailable for children in our country.

By increasing awareness about various NCDs in 22,000 children and adolescents (school and community), the health care burden due to NCDs can be reduced. This project could serve as a model to study the feasibility and viability of a well-planned NCD prevention program for children and adolescents in India and other developing countries. This project will also help launch the WHO HPS initiative in 50 schools in Chennai. This can help increase awareness of NCDs in addition to improving basic health and hygiene facilities in these schools. This project is expected to make a positive change in the health of 20,000 school students and 2000 children and adolescents from colonies, and through them, reach out to at least 100,000 adults. This, hopefully, can help bring about healthy behavior change in a large metropolitan city and thus serve as a model for the rest of the country.

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Dr. Ranjani designed and coordinated this study and helped in manuscript writing. Ms. Sonya wrote the first draft of the manuscript, which is part of her ongoing Ph.D. work. Dr. Pradeepa revised the manuscript. Dr. Mohan conceived, supervised, and was involved in writing all drafts of the paper. Dr. Mohan will act as guarantor of the study.

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