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# A Screening Program for Overweight Status Among Schoolgirls in Saudi Arabia: A Proposed Co-design Project to Tackle the Problem*

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The paper realizes the importance of communicating with schools to conduct nutritional screening, assessment and intervention programs for obesity and related risk factors to tackle the problem at earlier stage. The screening program was conducted by dietetics' students "under supervision" as part of their practice and community services to apply some assessment method for nutritional status. Two intermediate schools for girls in Jeddah city were involved in the screening stage, followed by a full nutritional assessment and implementation of a designed intervention program at one of the schools. At screening stage, interview questionnaires for diet histories and anthropometric measurements used to screen overweight status and related food patterns. National and international references data used for assessment and comparison. Following screening approach, a designed comprehensive nutritional assessment and intervention program was piloted at one of the screened schools for overweight status. For screening stage: the overall prevalence of overweight girls is 61% ($n$ = 81 out of 133) of the population, 73% ($n$ = 91) of girls were centrally obese. Almost 3/4 of all students reported no participations in any type of physical activities/exercises. Dietary behaviors included non-consumption of breakfast (83%) and low intake of fruit and vegetables (38%). For intervention stage, the present report concentrates on data concerning post intervention changes in Body Mass Index (BMI) and Waist Circumference (WC). By the 30 days of intervention there were significant changes in values for BMI according to Saudi growth chart ($p$ value = 0.009) with no changes among the control group. No statistically significant difference in the mean WC of the group. Study's results suggest that approaching young girls through schools to screen, assess and intervene overweight status and risk factors is vital. Although the non-random selection of only two schools for screening the prevalence of overweight status among

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school girls prevent the generalizability of the study findings to wider population, previous studies used random selection of schools and large sample sizes showed a high prevalence of overweight status among Saudi students. Therefore, designing and piloting of an intervention program for implementation at a national level is useful to tackle the problem.

*Keywords:* screening program, nutritional assessment, overweight status, intervention programs, diet histories, anthropometry, dietetic students

## Introduction

Researchers face methodological and ethical challenges when communicating or conducting research with children and young adults (Alderson & Morrow, 2011). Globally, the number of young adults is increasing continually and about 25% of the population in Kingdom of Saudi Arabia are young (Naeem, 2013). During adolescence, the rate of growth increases rapidly. This is associated with emotional, cognitive and hormonal changes and increased nutrition demands.

Young population are susceptible to different nutrition-related problems including malnutrition, which include obesity and eating disorders (WHO, 2005). Saudi researchers had competently studied and addressed the problem of obesity in many regions of the country (Farrag, Cheskin, & Farag, 2017).

Surveillance studies in which the weight status is assessed are supportive in defining population-based trends in obese children and youth (Ogden, Carroll, Kit, & Flegal, 2012). Nutritional assessment of weight status include dietary and anthropometric assessment.

Interest in dietary intakes and histories of individuals was recognized for decades and methods of dietary histories (DH) were validated earlier in the 20th century (Bransby, Daubney, & King, 1948). Validation of the use of DH approach was also conducted on Saudi schools for girls (Aljaaly, 2015).

The Institute of Medicine (IOM) have called for Body Mass Index (BMI) screening or surveillance in school settings (IOM, 2004). Body mass index (BMI) or Quetelet index [BMI; wt (kg)/ht (m)2], is commonly used as a tool to assess weight status (body size) in all age groups. Definitions of weight status in adolescents do not follow the same criteria as that of adults. Studies done so far show Saudi researchers have used multiple measures to assess growth and nutritional status of Saudi adolescents. However, a comprehensive nutritional assessment using different measurement to assess obesity have not been dealt with in depth and not been emphasized in different settings, particularly clinical settings (Aljaaly & Khalifa, 2016).

Anthropometric measures, including height, weight and BMI were frequently used to monitor growth in Saudi adolescents and to assess their weight status. The measures were referred to different international standards for comparison, which was applied on Saudi schools girls (Aljaaly et al., 2011).

Childhood and adolescence demand the use of age specific standards and the 50th centiles BMI values change with age. The World Health Organization (WHO) published updated growth charts in 2007 for weight status in children and adolescents (De Onis et al., 2007). Adolescent obesity is defined as a BMI-for-age equal or greater than the 95th percentile and adolescent overweight between the 85th and 95th percentile. Adolescent underweight is defined as a BMI-for-age less than the 5th percentile on the WHO growth charts (WHO, 1995).

El-Mouzan et al. (2007) has established the reference growth charts for Saudi Arabian children and adolescents aged from birth to 19 years. The data was entirely based on and collected from Saudi children and adolescents (urban/rural), from 13 administrative regions of the Kingdom of Saudi Arabia. The anthropometric

data comprised 51,485 observations of which 25,987 are made on boys and 25,498 on girls. The authors recommended the use of these charts by clinicians practicing in Saudi Arabia, or those belonging to other countries, when assessing children and adolescents growth. However, no studies "to our knowledge" has used or reported the use or application of these growth charts.

The BMI-for-age charts for children ages 2-19 years are recommended to be plotted on growth grids and then to be compared to indicators of weight for height status for adolescents to determine whether individuals are maintaining their growth patterns (Mahan & Escott-Stump, 2004).

Changes in weight reflect short-term nutrient intake and are regarded as a general indicator of nutrition status and overall health. The increase in BMI, which has been considered as a good indicator of adiposity in adults was significantly linked to increased risk of morbidity and mortality. Waist circumference (WC) is considered as an indicator of adiposity, and it reflects total abdominal fat levels. Adult men and women with waist circumferences of >102 cm and >88 cm, respectively, are considered at high risk of obesity-related disorders (National Institutes of Health 1998). Saudi investigators have used WC as an indicator of adiposity in children and adolescents (Aljaaly, 2014; Collison et al., 2010; AL-DISI, 2008). Therefore, it is optimal for the health of students to have the opportunity to achieve and maintain their weight. This could be through the assurance of resources for schools' interventions among students themselves and the environment they live in. School policies and research are important to promote healthful eating and lifestyle behaviours (IOM, 2004).

Screening programs to assess nutrition status for young girls was conducted in different areas in Saudi Arabia including Jeddah city. The prevalence of overweight and obesity among young population in Saudi Arabia was recognized by a number of studies. In Jeddah city, about one fourth of the adolescent girls (24%, $n$ = 366 out of 1519) are overweight or obese (Aljaaly et al., 2011). The same study showed that the overall prevalence of overweight status (BMI $\geq$ 85th and < 95th percentile) was 10.6% ($n$ = 161), whereas the obese girls constituted 13.5% ($n$ = 205) of the studied population using the cut-off (BMI $\geq$ 95th percentile). Approximately, 62% ($n$ = 935) of this population had a BMI-for-age within the normal range of between BMI $\geq$ 5 to $p$ < 85th percentile. Another school-based study was carried out in 13 regions in Saudi Arabia at intermediate and secondary levels concerning growth and nutrition status and food patterns. Students reported behaviours that were significantly linked to their health problems. The study indicated that 30% of students are either obese or overweight, 15.2% are underweight, 10% are anaemic and 95.6% are vitamin D deficient (AlBuhairan et al., 2014).

Defined factors that affecting eating behaviours and weight status of young girls in Saudi Arabia confirmed public health implications (Aljaaly, 2015).

School research and multilevel interventions are feasible and sustainable ways to promote healthful eating and lifestyles for young population (WHO, 2006). The concept of adopting programs and activities with the view to promoting healthy living and practices in schools was implemented, to some extent, in Saudi Arabia. The concept was endorsed in different localities in Saudi Arabia; however, measurable outcomes were not recorded or totally evaluated, and the programs were mainly applied in boys' schools (Aljaaly, 2012). Looking at the current regional obesity intervention projects, sadly and "to our knowledge", there are very few data quoted for the Gulf region although there is evidence suggesting an increase in prevalence of nutrition related non-communicable diseases in the region. Moreover, globally obesity in adults is estimated at 68.8% using BMI cut off point of 25 kg/m$^2$ or more (WHO, 2012). Based on reviews on obesity prevention, school-based interventions were recommended to target enhancement of physical activity and healthy nutrition to decrease

Body Mass Index (BMI). It was also recommended to include changing in physical activity behaviours and increasing the duration and types of different activities. Increasing fruit and vegetable intake, which is very low among Saudi girls (Aljaaly, 2015) and reducing the intake of sweetened drinks was also recommended to be included in intervention programs. Guidance on the prevention and management of overweight and obesity in children was prepared by many countries (NIH, 2006). Therefore, the aim of the present study was to introduce and pilot the implementation of a full designed nutritional assessment and intervention programs on a previously screened intermediate schools for overweight status in Jeddah city. The implementation of such pilot programs can be justified in larger studies and at national level where time can then be saved in programs application.

## Methods

The study is to screen overweight status[1] among two schoolgirls at intermediate level as part of a community work and practice of methods related to assessment of nutritional status at community level. Both schools were screened upon agreement of school administrations and no randomization was considered. The screening process was conducted (in the academic year 2014-2015) by faculty members and students of the dietetics program at king Abdulaziz University in Saudi Arabia. This work which confirmed the same prevalence rates of overweight status (24%) for a previous work on a large randomized sample (Aljaaly et al., 2011) was followed by designing an intervention program to tackle the problem. The intervention program was piloted (in the academic year 2015-2016) at one of the previously screened schools.

The study objectives: 1. "to screen overweight status by measuring anthropometric profiles [weight (WT), height (HT), body mass index (BMI) and waist circumference (WC) of participants]". Assessment of overweight status was based on two reference data (national and international). 2. To test the feasibility and acceptability of a designed school-based intervention program, tools and test procedures for a Randomized Controlled Trial of weight and behavioral change in a sample of overweight girls with possible risk factors for disease.

Two female schools at intermediate level (private and governmental) were recruited through the Ministry of Education in Jeddah, Saudi Arabia and with permission from their respective principle teachers. The study is mainly designed based on two stages: 1. The nutritional screening stage of overweight status among students (in the academic year 2014-2015). 2. The carrying out of a full nutritional assessment, followed by an intervention program on students who were previously screened as overweight. The intervention program was only applied on one school in the academic year 2015-2016.

This report presents the two following programs: the screening and the intervention one for overweight status:

In the first stage, the population under investigation were recruited as clusters from classes for all grades (1, 2 & 3) at the two screened schools (two classes at each level were selected randomly).

- Diet history interview: Some girls were randomly interviewed to generally screen the dietary patterns for young girls. Interview forms for a brief of interview dietary history (DH) approach that was previously validated on Saudi schools for girls (Aljaaly, 2015) was used.
- The screening process consisted of measures for height, weight and waist circumferences (WC) assessment. This is to define overweight status and possible risk factors. The used measurement procedures

[1] Overweight status: in this study is defined for those who are either overweight or obesity.

were used by the main investigator in previous studies (Aljaaly et al., 2011; Aljaaly, 2015) and the research team were trained well in using them before data collection:

(1) Measurements for height were carried out using a single standard stadiometer for height and measured to the last 0.1 cm.

(2) Measurements for weight were conducted using portable calibrated Seca scales. Weight was measured without shoes and was read to the nearest 0.1 kg.

(3) A standard tape measure in centimeters was used for waist circumference measurements, which was placed around each participant's abdomen. The narrowest part between the lower rib and the iliac crest was the site of measurement.

- Body mass index (BMI) was calculated for each student using the ratio of weight to height square and BMI was determined where BMI = Weight (kg) / Height 2 (m).
- Reference data for BMI: For BMI distribution, BMI for each student was plotted on growth grids using the BMI-for-age charts for children and adolescents. BMI distribution was compared with two references: 1. The Saudi Growth Charts for Body Mass Index-for-age (3 to 19 years old) percentiles for Saudi girls (El-Mouzan et al., 2007) and 2. The 2007 WHO reference for BMI for children and adolescents (2-19 years) (De Onis et al., 2007).
- Weight categories: Students were grouped into two categories according to their weight status: overweight and obese. Weight categories were defined in terms of percentiles using the WHO 1995 guidelines for BMI classification by age and gender. The cut-off percentiles used to classify the weight status were overweight, $p \geq 85$ to $p < 95$; and obese, BMI $p \geq 95$ (WHO, 1995).
- Waist circumference status and reference data: The mean values for waist circumference (WC) for schoolgirls was plotted and compared with the United Kingdom reference data that was developed for waist circumference percentile curves for British girls aged 5.0 ± 16.9 years (McCarthy, Jarrett, & Crawley, 2001). Age and gender-specific WC were divided into percentiles according to Fernandez et al. 2004 ≤ 10th percentile; ≥ 10th and ≤ 75th percentile; ≥ 75th and ≤ 90th percentile and ≥ 90th percentile.
- Ethical issues for screening stage: the screening protocol was approved by the Ministry of Education and the Research Ethics Committee at the Faculty for Medical applied College at King Abdulaziz University in Saudi Arabia. School head teachers were requested to provide a research team along with a signed consent form by each student who is willing to participate in the study before recruiting them. Schools together with the research team delivered standard written information to students on the study, data protection and right of withdrawal. During the visit, the research team informed each student about her weight status and provided the needed health and nutrition information and consultation.

Step following screening: the confirmed students as overweight or obese in the screening stage were recommended to be involved in the intervention study in the following academic year. The study was targeting the two intermediate schools previously screened for overweight status (Public and Private) to pilot the structured intervention program. However, the program was applied only on the Private school who approved the intervention stage of the study. The school provides education at intermediate and high school levels. Screening program was re-conducted at the recruited school in the academic year 2015-2016 to accommodate the newly enrolled students. Chances for participation included all students ingrades 1, 2 & 3 in the intermediate level and in grade one at the high school level (those who were in grade three) in the previous academic year. A total of 99 students agreed to be screened for weight status and 35 (35.3%) were defined to

either be overweight or obese based on comparisons to two reference data "the 1995 WHO" and "the 2007 Saudi growth charts" for girls aged 2 to 18 years. The study included overweight students those agreed to participate in the intervention (diet, lifestyle & behavioural change: see Figure 1) program in the academic year 2015-2016. The research team requested participants to return a signed informed consent forms by them and their parents before recruitment in the intervention program. Ethical Approvals for conducting the intervention study obtained from the Research Ethics Committee at the Faculty of Applied Medical Sciences in King Abdulaziz University, Ministry of Education and principal teachers for schools. There are no expected risks linked with joining in the current study. In addition, the investigational program helps to correct weight status, and withdrawal of the participant at any time will not affect participant safety. Therefore, participants understood well that they can withdraw from the study at any time.

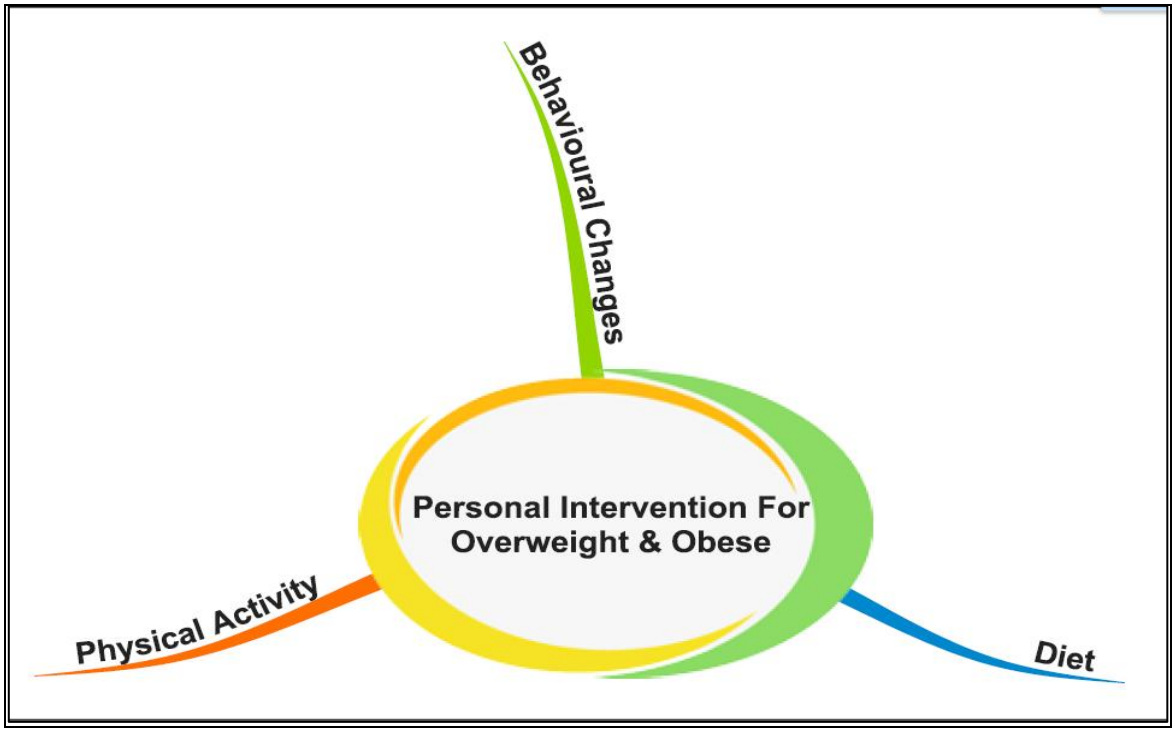


*Figure 1.* Intervention Program at individual level.

**Study Design & Duration**

The study is a school-based controlled trial with measurements pre, and 30 days post intervention. The study was piloted in one school following screening approach for overweight status, and upon request and agreement of the school administration, in the academic year 2015-2016.

**Study Procedures for Nutritional Assessment**

The research team conducted a pre and post intervention nutritional assessment approach for the recruited overweight students using some tools (see Figure 2).

The assessment for the proposed intervention included questionnaires, anthropometry, physiological and biochemical blood test and five visits took place. Measurements included weight, height, waist circumference (WC), blood pressure monitoring (BPM), fat percentage, capillary random blood glucose (finger prick) and venous blood test (lipid profile) at baseline, every week (for 4 weeks) and after the intervention. Applying a

follow up process on a weekly basis was to ensure the participant's compliance and safety in completing the weight control program.


*Figure 2.* Mind mapping for the pre and post intervention assessment tests/tools.

**Hypotheses for the Intervention Study**

We hypothesize that the communicating with and recruitment of schoolgirls for nutritional screening and assessment, intervention and related measurement and test procedures will be practical and suitable, thus allowing to carry on with randomized trials and applying of such programs at national level.

**The Intervention Program**

Approaches at a personal level, to tackle obesity and opportunities for behavioral change (food patterns & physical activity) are aspects of public health procedures that can influence weight management among young girls. The present study introduced a proposed intervention program with challenging results (at personal level) to manage obesity among young girls at an early stage. As a result, the study followed the recommendations of reviews on obesity prevention and school-based interventions and designed the program to target enhancement of physical activity (Janssen & LeBlanc, 2010) and healthy nutrition to decrease Body Mass Index (BMI). Instructions included changing in food and physical activity behaviors and increasing the duration and types of

different physical activities. Increasing fruit and vegetable intake and reducing the intake of sweetened drinks was also included in the plan.

## Results

**For Stage One**

The study sample comprised of 133 female students aged from 13 to 15 years. Students were recruited from a one private and one public school in Jeddah city. Obtained diet history showed that students are generally more likely to consume snacks (87%), which were less healthy. Skip meals, particularly breakfast was reported by 83% of the students. On a daily basis, about 55% of the girls were consuming full sugar carbonated beverages. Girls (80%) were adding sugar to the consumed hot and cold beverages. Daily consumption for fruit and vegetables was reported by only 38% of students.

The main outcome measures of this study included body mass index (BMI) and waist circumference (WC) as body-fat measurements. Table 1 shows the BMI classification of participants using the WHO reference data. Among public school students ($n$ = 65), overweight girls ($p \geq 85$ to $p < 95$) were 21.5%, $n$ = 14. Obesity (BMI $p \geq 95$) = 20%, $n$ = 13. Among students in private school ($n$ = 68), 25%, $n$ = 17 of the girls were overweight and 7.4%, $n$ = 5 were obese. Prevalence of overweight/obesity in both schools using WHO Charts was 23.3% ($n$ = 31) and obesity was 13.5% ($n$ = 18). Therefore, a total of 49 out of 133 students (36.8%) were either overweight or obese when compared with WHO reference data.

Table 1

*Body Mass Index Classification of Participants (WHO Reference Data)*

| School type | Overweight<br>BMI ≥ 85th & <95th percentile | Obesity<br>BMI ≥ 95th percentile |
|---|---|---|
| Public School ($n$ = 65)<br>Overweight/obesity (41.5%), $n$ = 27 out of 65 | 14 | 13 |
| Private School ($n$ = 68)<br>Overweight/obesity (32.4%), $n$ = 22 out of 68 | 17 | 5 |
| Total | 31 | 18 |

Table 2 shows the BMI classification of participants using the Saudi reference data. The prevalence of overweight status in the public school was 15.4%, $n$ = 10 and 12%, $n$ = 8 of girls were classified as obese. In the private school, 16.2%, $n$ = 11 were overweight and 4.4%, $n$ = 3 were obese. Therefore, the prevalence of overweight status in both schools using Saudi growth charts was 15.8%, $n$ = 21 and for obesity was 8.3%, $n$ = 11. As a result, a total of 32 out of 133 students (24%) were either overweight or obese when compared with the Saudi reference data. Figures 3 and 4 present the Mean BMI for participants based on the WHO and Saudi Growth Charts for schools from public and private sectors.

Table 2

*Body Mass Index Classification of Participants (Saudi Reference Data)*

| School type | Overweight<br>BMI ≥ 85th & <95th percentile | Obesity<br>BMI ≥ 95th percentile |
|---|---|---|
| Public School ($n$ = 65)<br>Overweight/obesity (27.7%), $n$ = 18 out of 65 | 10 | 8 |
| Private School ($n$ = 68)<br>Overweight/obesity (20.5%), $n$ = 14 out of 68 | 11 | 3 |
| Total | 21 | 11 |

Waist circumference percentiles (WC): In comparison with the curves for British girls aged 5.0 ± 16.9 years, the percentage of girls with waist-circumference scores ≥ 90th percentile was higher in both sectors. WC for 69% of girls in the private schools scored ≥ 90th percentile, compared to 45% in public schools (see Figure 5). Seventy-three percent ($n$ = 91) of girls were centrally obese (when WC at 75th percentile was used).

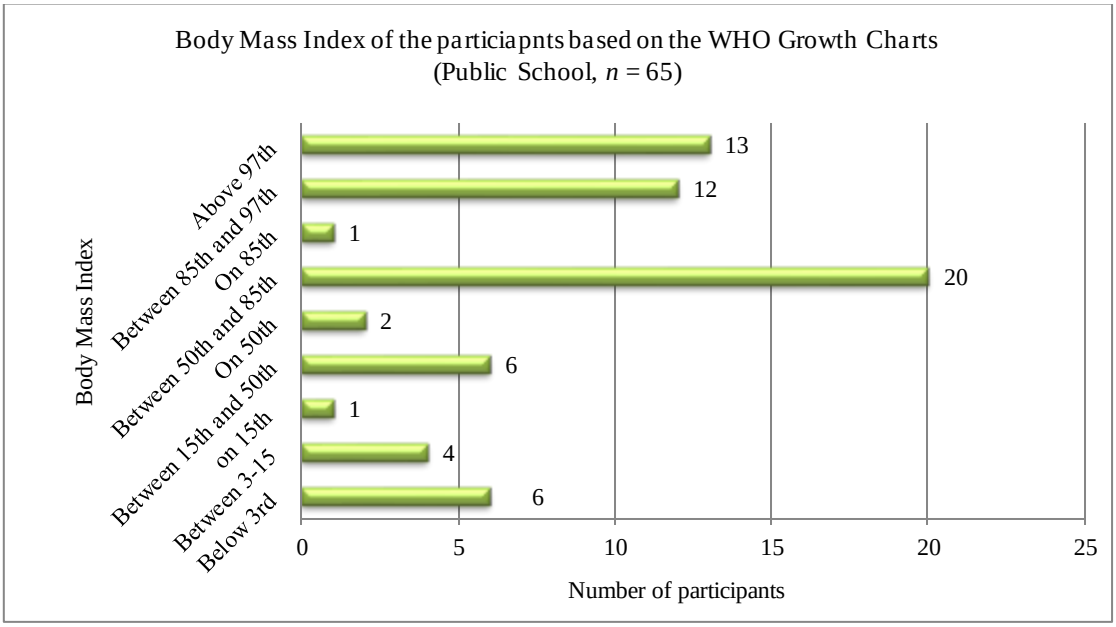


*Figure 3a.* The Mean BMI for participants based on the WHO Growth Chart (Public school).

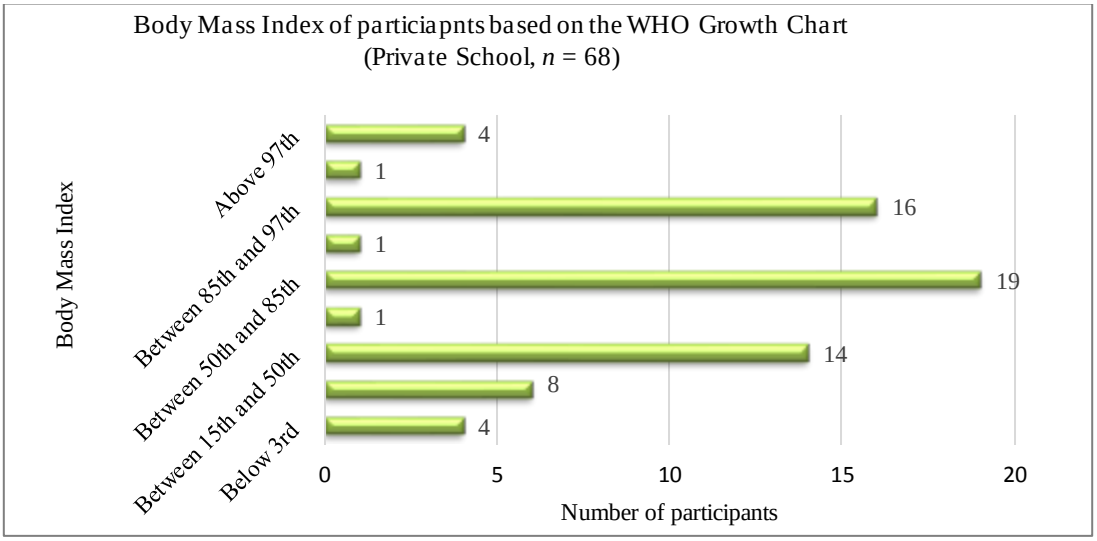


*Figure 3b.* The Mean BMI for participants based on the WHO Growth Chart (Private school).

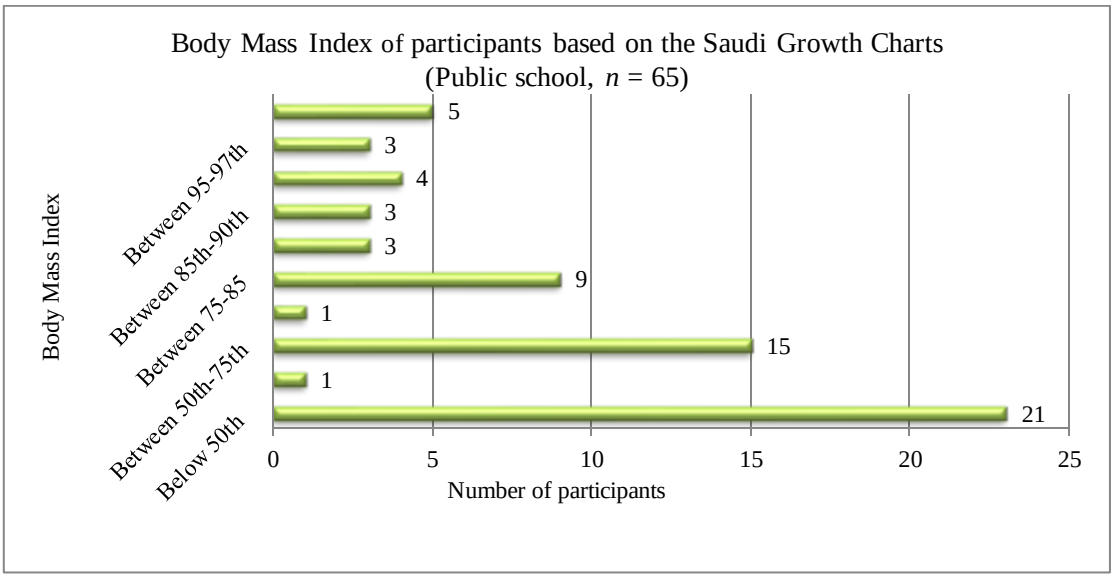


*Figure 4a.* The Mean BMI for participants based on the Saudi Growth Chart (Public school).

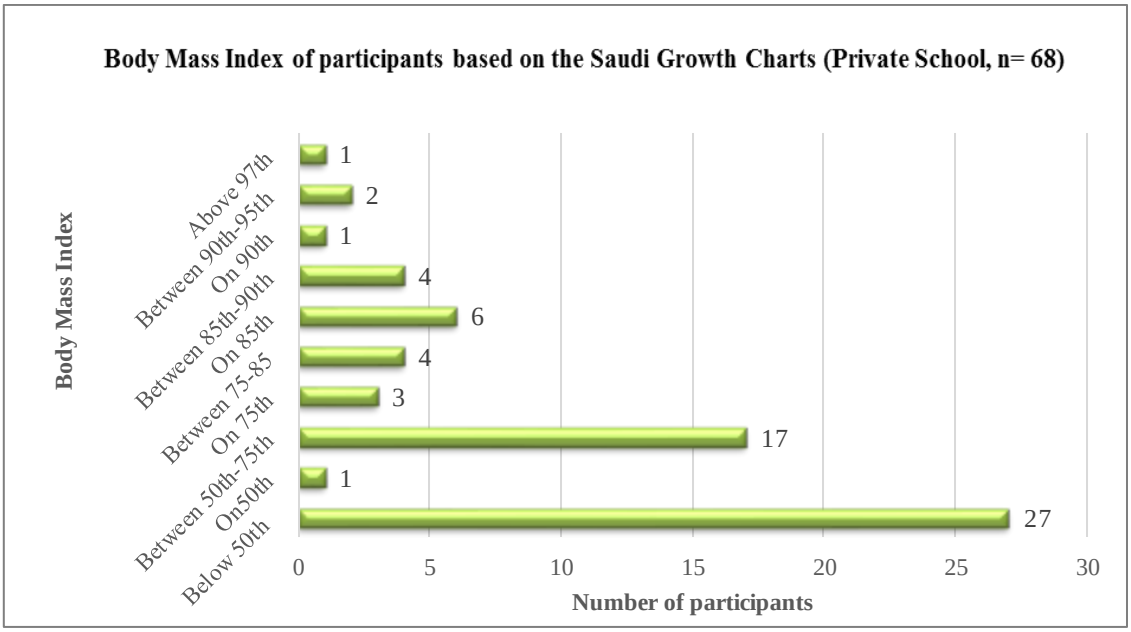


*Figure 4b.* The Mean BMI for participants based on the Saudi Growth Chart.

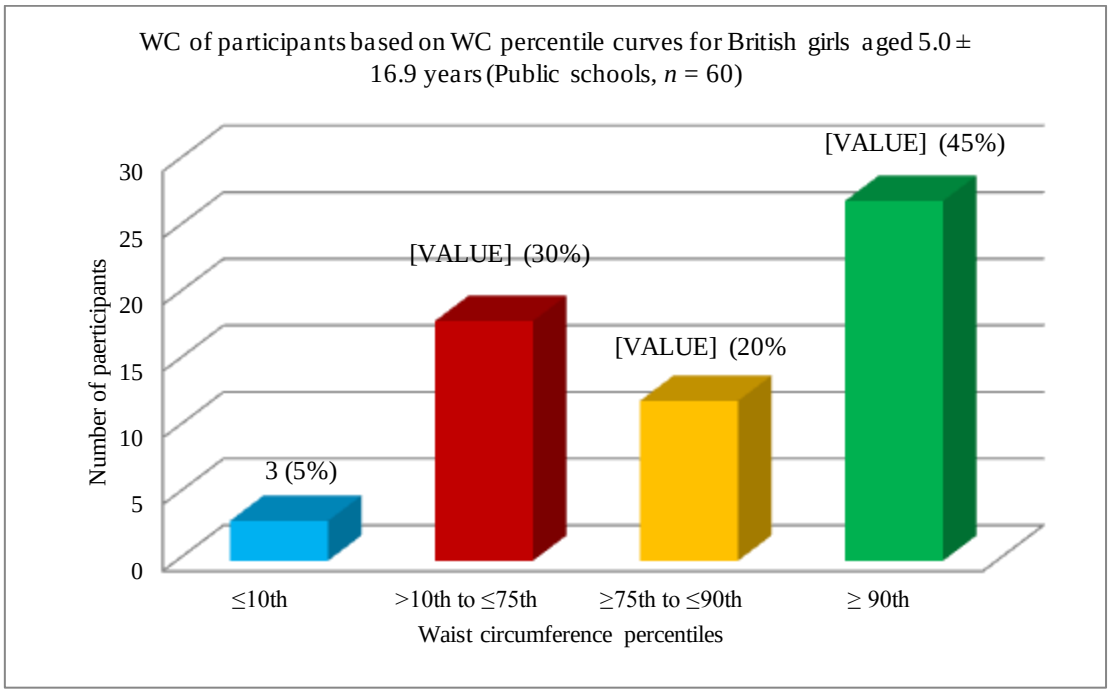


*Figure 5a*. Comparison of mean WC with WC percentile curves for British girls aged 5.0 ± 16.9 years (Public school).

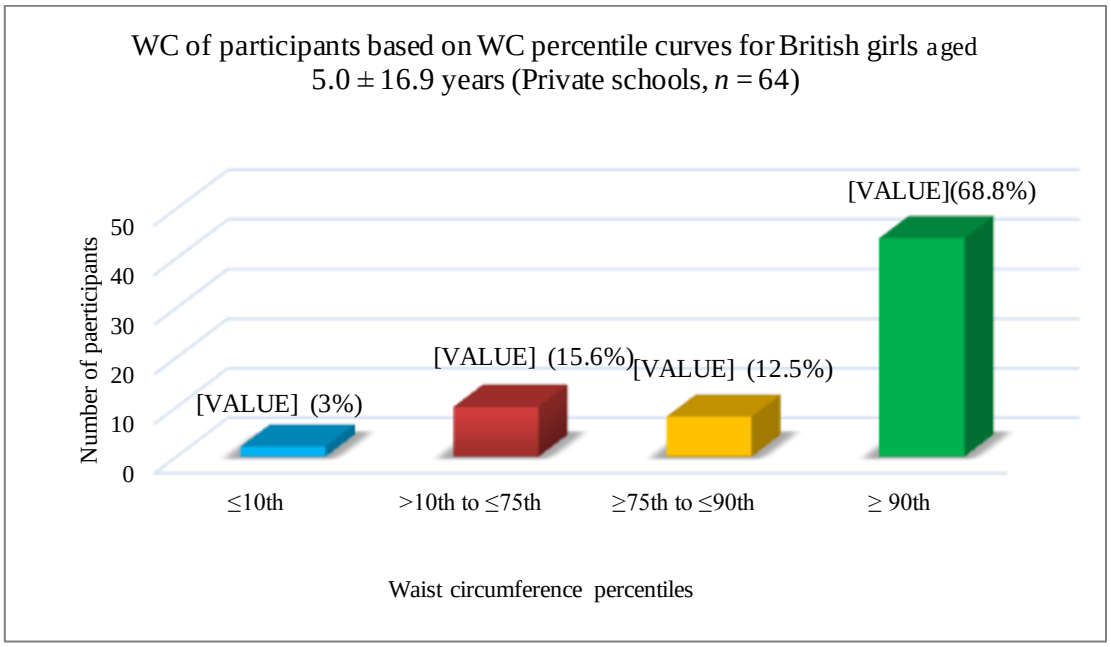


*Figure 5b*. Comparison of mean WC with WC percentile curves for British girls aged 5.0 ± 16.9 years (Private school).

**Results for Stage Two**

Recruited overweight students who agreed to participate in the intervention study were 80% ($n$ = 28 out of 35). Participants were randomly allocated to the "intervention" or "control" group. The used ratio was 7:1. Therefore 24 students applied the intervention program and four students were in the control group. More than three quarters (82.2%) of the studied sample aged 13-15, while (17.8%) aged 16 years, with a mean of 14.035. We included those aged 16 years in the intervention study as they were previously recruited as overweight or

obese before moving to high school level in the same school. A total of 42.9% ($n$ = 12) of the recruited students were in grade 7, (25%, $n$ = 7) in grade 9, (14.3%, $n$ = 4) in grade 8 & (17.9%, $n$ = 5) in grade 10. Table 3 presents changes in different measurements among the intervention group: Anthropometric measurements (weight, BMI), Body composition measurement (Fat %), Muscle strength, Random blood glucose monitoring (Finger Prick) and blood pressure (Manual Inflation Digital Blood Pressure Monitor) before and after the intervention program. Changes in performing physical activities and behavior change for the intervention group is also included. Based on comparisons of the baseline data and data at day 30, significant changes were noticed in values for random blood glucose levels ($p$ value = 0.048), hand grip ($p$ value = 0.027) and BMI according to Saudi growth chart ($p$ value = 0.009). However, no significant changes were found concerning other parameters. Comparisons for values for all measurements among the control group, in Table 4 showed no significant changes in day 30 when compared with the baseline data. No statistical significant differences in all data for blood results (see Table 5) for both the intervention and non-intervention group at day 30 ($p > 0.05$). However, Positive slight changes were noticed concerning the values for HDL and TG. For technical problems in the reservation of the collected blood samples for participants, which is explained below in the limitation part of the study. No comparison was made between the two groups. Table 6 presents results for participants responses in both groups and changes in responses at day one and day 30 for different behaviors and perceptions are presented. Results showed significant changes in perceptions of intervention group such as "of being healthy" ($p$ value = 0.031), "performance of physical activity" ($p$ value = 0.003) with no changes among the non-intervention group. However, significant changes in response to the performance of physical activity ($p$ value = 0.005) were found among the two groups at day 30.

Table 3

*Changes in Measurements for the Intervention Group*

| Parameters | | Group | *N* | Mean | SD | *t* | DF | *P* value |
|---|---|---|---|---|---|---|---|---|
| Weight (kg) | | Pre | 24 | 67.3708 | 10.79152 | 0.905 | 23 | 0.375 |
| | | Post | 24 | 66.8500 | 9.58400 | | | |
| Blood glucose (mg/dl) | | Pre | 24 | 86.1250 | 13.26425 | 2.084 | 23 | 0.048 |
| | | Post | 24 | 79.4583 | 9.48674 | | | |
| BP (mmhg) | | Pre | 24 | 129/78 | 9.28914 | 1.361 | 23 | 0.187 |
| | | Post | 24 | 157/74 | 38.54002 | | | |
| Fat % | | Pre | 24 | 36.7375 | 4.31839 | 0.806 | 23 | .429 |
| | | Post | 24 | 36.1583 | 3.81506 | | | |
| Hand grip (kg) | | Pre | 24 | 18.4125 | 5.19643 | 2.360 | 23 | 0.027 |
| | | Post | 24 | 20.1792 | 4.38703 | | | |
| BMI | Saudi G.C. | Pre | 24 | 2.8333 | 0.38069 | 2.849 | 23 | 0.009 |
| | | Post | 24 | 2.2917 | 0.85867 | | | |
| | WHO G.C. | Pre | 24 | 2.6250 | 0.49454 | 1.904 | 23 | 0.070 |
| | | Post | 24 | 2.3333 | 0.63702 | | | |

*Note.* *P* Value is significant at < 0.05.

Table 4

*Changes in Measurements for the Control Group*

| Parameters | | Group | *N* | Mean | SD | *t* | *df* | *P* value |
|---|---|---|---|---|---|---|---|---|
| Weight (kg) | | Pre | 4 | 62.5000 | 12.44990 | 0.000 | 3 | 1.000 |
| | | Post | 4 | 62.5000 | 11.42366 | | | |
| Blood glucose (mg/dl | | Pre | 4 | 81.2500 | 3.68556 | 0.749 | 3 | 0.508 |
| | | Post | 4 | 76.5000 | 11.78983 | | | |
| BP (mmhg) | | Pre | 4 | 150/91 | 40.43410 | 1.080 | 3 | 0.359 |
| | | Post | 4 | 151/66 | 38.54002 | | | |
| Fat % | | Pre | 4 | 34.7250 | 8.85038 | 0.262 | 3 | 0.810 |
| | | Post | 4 | 34.4750 | 7.16676 | | | |
| Hand grip (kg) | | Pre | 4 | 20.1250 | 4.40028 | 0.198 | 3 | 0.856 |
| | | Post | 4 | 19.6500 | 1.71367 | | | |
| BMI | Saudi G.C. | Pre | 4 | 3.0000 | 0.00000 | 1.000 | 3 | 0.391 |
| | | Post | 4 | 2.5000 | 1.00000 | | | |
| | WHO G.C. | Pre | 4 | 3.0000 | 0.00000 | 2.449 | 3 | 0.092 |
| | | Post | 4 | 2.0000 | 0.81650 | | | |

*Note. P* Value is significant at < 0.05.

Table 5

*Changes in Lipid Profile (TG, CHOL, LDL, and HDL) Among all Participants at Day 30*

| Parameters | | *N* | Mean | SD | *T* | Df | *P* value |
|---|---|---|---|---|---|---|---|
| TG | Pre | 22 | 0.9509 | 0.40790 | 0.072 | 21 | 0.944 |
| | Post | 22 | 0.9427 | 0.34993 | | | |
| CHOL | Pre | 22 | 3.6136 | 0.78041 | -1.934 | 21 | 0.067 |
| | Post | 22 | 3.9936 | 0.70501 | | | |
| LDL | Pre | 22 | 2.2032 | 0.61095 | -1.548 | 21 | 0.137 |
| | post | 22 | 2.4705 | 0.71934 | | | |
| HDL | Pre | 22 | 1.1591 | 0.35139 | -0.552 | 21 | 0.587 |
| | post | 22 | 1.2073 | 0.26913 | | | |

Note. *P* Value is significant at < 0.05.

Table 6

*Perceptions and Behaviors at Baseline and Postintervention for Intervention and Control Group*

| Variable | Intervention Group (mean) | | Control Group (mean) | | Post-intervention *P* Value (Intervention & control groups |
|---|---|---|---|---|---|
| | Pre-intervention | Post-intervention | Pre-intervention | Post-intervention | |
| | Value *P* | | Value *P* | | |
| Considering themselves healthy | 1.03750 | 1.6250 | 1.0000 | 1.7500 | 0.644 |
| | 0.031 | | 0.058 | | |
| Meal size affected by presence of friends and family members | 1.5000 | 1.2917 | 1.0000 | 1.7500 | 0.082 |
| | 0.203 | | 0.058 | | |
| Skipping meal | 1.7917 | 1.7917 | 1.5000 | 2.0000 | 0.332 |
| | 1.00 | | 0.182 | | |
| Buying from school canteen | 1.6250 | 1.500 | 1.2500 | 1.2500 | 0.372 |
| | 0.266 | | 0.638 | | |
| Following special diet | 1.3750 | 1.5417 | 1.500 | 1.500 | 0.883 |
| | 0.162 | | 0.391 | | |

(Table 6 continued)

| Variable | Intervention Group (mean) | | Control Group (mean) | | Post-intervention *P* Value (Intervention & control groups |
|---|---|---|---|---|---|
| | Pre-intervention | Post-intervention | Pre-intervention | Post-intervention | |
| | Value *P* | | Value *P* | | |
| TV watching influence on eating behaviour | 1.5833 | 1.2083 | 1.500 | 1.2500 | 0.858 |
| | 0.119 | | 0.182 | | |
| Involved in food preparation or cooking at home | 1.5833 | 1.4583 | 1.5000 | 1.7500 | 0.297 |
| | 0.185 | | 0.638 | | |
| Performed any kind of physical activities outside school | 1.6250 | 1.6583 | 1.500 | 1.500 | 0.005 |
| | 0.003 | | 0.391 | | |

*Note.* *P* Value is significant at < 0.05.

## Discussion

The project aimed to introduce and pilot the implementation of a co-design intervention programs on a previously screened and comprehensively "nutritionally" assessed intermediate school for overweight status in Jeddah city. The program to be applied on more schools, which could then allow for implementations at a national level.

Students of two school from two sectors (public and private) were screened to define their overweight and centralized fat status in the academic years 2014-2015. The published 2007 World Health Organization (WHO) growth charts, which depends on data from widely different ethnic backgrounds and cultural settings was used in this study. In addition, the Saudi growth charts that was developed in 2007 were also used. Both growth charts used to screen and assess growth status of the studied population. A comparison of the overweight status was made based on both references.

Using BMI as an outcome measure, allowed research team to assess the overweight and obese status of the studied population when compared to the two reference data. BMI-for-age was stratified into two risk-based BMI categories, overweight and obesity. The overall prevalence of overweight and obesity was about 37% ($n$ = 49) of the study population "when compared data to WHO reference data". However, the prevalence was lower when data was compared to the Saudi reference data (24 %, $n$ = 32). The main author has previously compared both references (national and international) for girls (13-18 years) (see Figure 6) (Aljaaly, 2012). The range of percentiles involved six percentile curves: (5th, 25th, 50th, 75th, 85th, and 95th). The comparison demonstrated that for 13 year-old girls, compared to WHO standards, the BMI of Saudi girls is lower at the fifth and twenty fifth percentile while at the 50th percentile and the higher percentiles, Saudi girls show an average BMI higher than the international level. For 14, 15, 16, and 17 years, only up to the 25th percentile, the BMI of Saudi girls is lower than the average international level and for the rest of the BMI's distribution, Saudi girls show an average BMI higher than the one for international level. The present study showed that 82% (99 out of 121) of students (aged 13 to 15 years) were above the 50th percentile, when compared to the WHO data. On the other hand, 69% (84 out of 121) were above the 50th percentile, when compared to the Saudi data. This means that when comparing the average BMI for Saudi girls with international data, the percentage for those who are above the 50th percentile will appear higher, compared to the data that linked to the national references. This will also reflect on the total prevalence of overweight and obesity since it will be higher based on international standards.

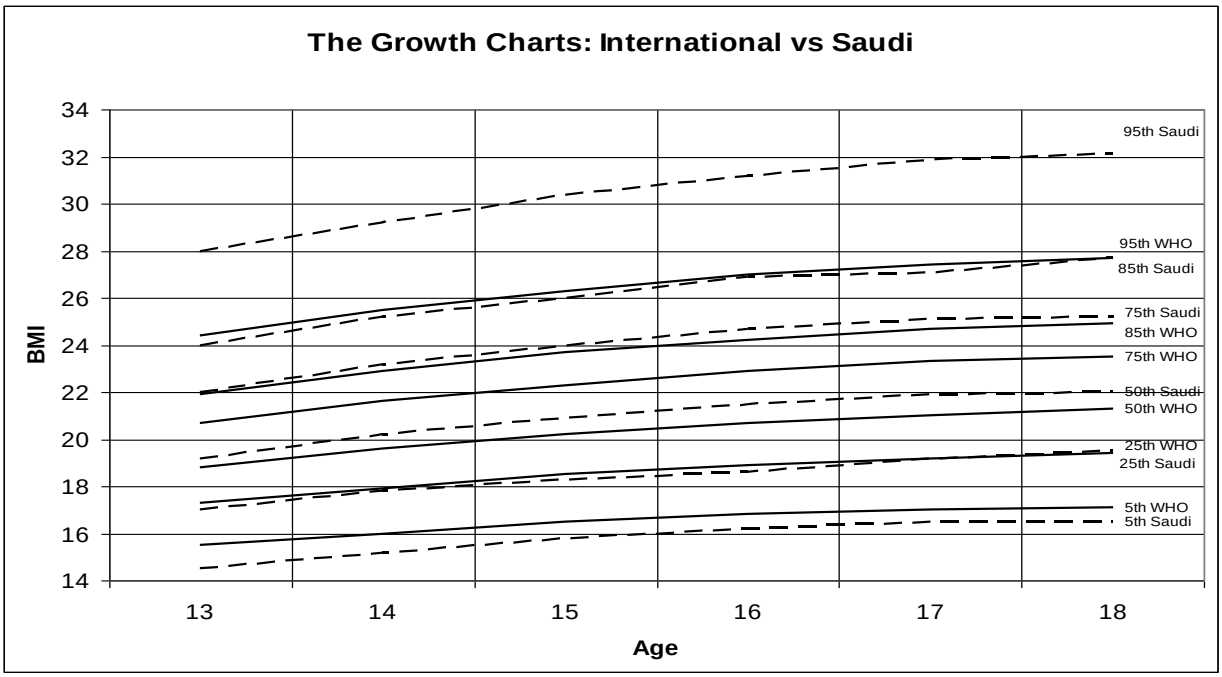


*Figure 6.* A comparison between the Saudi and WHO for BMI reference data for girls (13-18 years). (----- Saudi girls) & (__ WHO). Source: Aljaaly (2012). Reproduced with permission from the author.

A national or regional assessment of young girls' WC reference values was suggested by previous research to be used because these values may differ from one country to another. This will help to avoid the variations in the WC phenotype that is probable to be explicated by genomic and environmental factors (Hatipoglu et al., 2007). However, the mean values for waist circumference (WC) for the present studied population followed the Jeddah adolescent girls approach (Aljaaly, 2014) and the study for Collison et al. in 2010, which compared data for the mean WC with the developed waist circumference percentile curves for British girls aged 5.0 ± 16.9 years (McCarthy et al., 2001). This was used as no national reference data was available to compare with at the time of comparison. The waist circumference measure was used to assess the centralized fat status and WC for girls was mostly within the scores ≥90th.

Obesity intervention programs at Saudi female schools showed that children form healthier eating and physical activity habits at young age. Additionally, review studies on childhood obesity interventions reported schools as the best settings for childhood obesity interventions (AlMarzooqi & Nagy, 2011).

In the intervention program that was applied on 28 participants at one school, results related to the intervention group showed significant changes in day 30 in random blood glucose level (finger prick), muscle strength (hand grip measurements) and BMI based on Saudi growth charts, compared to the control group. These results indicated the impact of physical activity as part of the intervention program on participants' health. In addition, a significant changes in random blood glucose level and BMI according to the Saudi growth chart was noticed. This could be due to the effect of diet as part of the intervention program. Other parameters did not show any significant changes and this could be due to the short duration of the study. More significant results could be found if the program was applied for longer period. Control group's results showed no significant changes in day 30 on the 6 parameters, this confirm the applicability of the pilot intervention program. Handgrip strength was recommended to be used in combination with other assessment tools and

clinical judgment when assessing malnutrition (WHO, 1995). Previous studies that included interpretation for handgrip for measuring muscle strength were mostly "to our knowledge" on adults and was clinical based. However, the present study, which is a community-based used this approach on adolescent girls and showed a significant difference (*p* value 0.027) pre and post intervention in the intervention group as the mean value for the muscle strength using the dominance hand was improved after the intervention from 18 to 20. The study interpreted the muscle strength individually for each participants based on age and then the mean value was considered for the mean age (14 years). The presented results for the mean value could be used in further studies as a suggested reference values for the functional evaluations of muscle strength of the hands in girls aged 14 years old (Report of a WHO Expert, 2013).

A cohort study conducted by obesity care program carried on pediatric patients aged 3.3 to 17.1 years, anthropometric measurements and medical history, motivational interviews, cognitive behavioral techniques including behavior awareness, psycho-education and changing behaviors and control stimulus carried on participants. The results showed significant decrease in BMI for 49.5% of the participants. These changes was depending on number of visits, age and BMI at baseline (AlFaris et al., 2015). Similarly, the present study followed the same approach in applying multiple visits to follow up participants while they were going through out the intervention program.

One of the comorbidities of obesity is coronary heart disease (CHD). To identify individuals who were at risk to develop complications as a result of overweight status and would benefit from early treatment. Lipid profile test (TG, HDL, LDL, total cholesterol) was applied two times pre and post intervention for all participants in both groups. The participants had been asked to fast for 10-12 hours before conducting the blood tests. The plan was to compare between the two groups (intervention and control group) with regards to blood values for lipid profile, but because of some technical mistakes happened during the reserving of the blood samples at day one and day 30, which caused a mix up in the labelling of names for some blood samples. Considering all these reason, we conducted the analysis for all participants without considering if the student is belong to the intervention or the control group. Slightly positive changes were reported in values related to TG and HDL. However, these changes did not reach a significant level. The reason behind changes in TG and HDL for all participants might be related to the intervention group and due to the increase in their performance for physical activities and the changes in some eating behaviors based on intervention program. This was confirmed by Labayen et al. (2013). Similar findings in Southeast Spain was also reported, the study applied fitness program on 67 adolescents (12-14 years) those were separated to experimental and control group, the only parameter that was significantly ($P = 0.04$) showed reduction in blood values was the LDL and it was in the experimental group (Ardoy et al., 2011). The duration for the intervention program was 16 weeks, which is longer than the one for the present study.

## Limitations, Strength and Challenges

### Study Limitations

- The laboratory technical mistakes that occurred during the reserving of the blood samples at day one and day 30, which caused a mix up in the labelling of names for some blood samples. This limited the chance to apply comparison for blood tests between the intervention and the control group after applying the program. Therefore, lab technicians should be very careful in using the proper marking pens to allow for the correct result for the right samples.

- The screening study was basically conducted as a community work for the faculty members and students. The work aimed also to train students to practice some methods related to a nutrition assessment course and the selected two schools were chosen because they were nearby to the university. However, this non-random selection of the only two schools to define the prevalence of overweight and obesity among students prevented generalizability of the study findings to a wider population.
- The non-agreement for application of the intervention program by the public school administration did not facilitate comparison of results between the private and public schools.
- The short duration for intervention (30 days) may have affected the non-significant results for some results.

**Study Strength**

International reference data can be used to compare data for BMI and it is important to use one reference population for all recommended anthropometrical indicators for uniformity of reporting purposes. The present study used two reference data, the WHO and the Saudi growth chart and results showed significant changes in BMI when using the Saudi charts, compared to data when using WHO, which showed no significant difference. This could confirm the need to use national data at community and clinical practice whenever is available, which could be more representative to the studied population who are Saudi or grown up in Saudi. The study emphasized the importance of using the available national growth charts in further studies and clinical practice.

**Conclusion, Recommendation & Implications**

- Screening programs for obesity prevalence are valuable to define the need for further programs to address obesity and related risk factors among students. However, national and international reference data need to be considered when conducting national screening programs.
- In recent years, BMI has received increased attention for adolescent use, and it was recommended to be used routinely as a screening guideline for overweight young girls.
- The study followed expertise advice in screening weight status, followed by the developing of an in-depth assessment and a co-design intervention approach. This could enable a wide range of people to make a creative contribution in the formulation and solution of a problem. This include researchers, school administration, the Schools' Health, the Ministry of Education, the local authorities and the public and private sectors, and decision makers in a mutually supportive and coordinated way.
- The lessons learned from this study highpoint the controlling and logistic issues involved in an inclusive intervention.
- Dietetic students "under supervision of faculty members" had an opportunity to be involved in fieldwork training and in conducting surveys. They also learned to know how to deal with obese students and in communicating and working with schools. Relationships also shaped with the administration and students at other educational institutions, which offer possibilities for helping to sustain dietetics education efforts.
- Study's results suggest that approaching schools by dietetic professional and training students through schools to screen, assess and intervene overweight status and risk factors is useful to tackle the problem.

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