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# ORIGINAL ARTICLES

## Assessment of anthropometric measurements and nutrition information of some Saudi women in Abha city

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**ABSTRACT**

This research project aimed to improve the nutritional concepts and practices among Saudi women in Abha city. The ethical clearance and approval to conduct was obtained from the College of Medicine Ethical Committee at King Khalid University. Before participation, a signed consent from the subject was obtained after explaining the research project. The participant was free to withdraw from the program at any time without notification. Anthropometric measurements, blood sugar reading, and nutrition knowledge & practice were assessed using a pre-designed, pre-tested questionnaire through direct interview of the subject before and after providing a nutrition education program. More than 500 women began the program; however, only 360 completed it. Data were summarized and analyzed using SPSS statistical package. Significant differences were found between subject's responses to knowledge and practice questions before and after the workshops. Such improvement in responses was higher among women at younger ages. Anthropometric measurements (BMI, weight as percentage of ideal weight for the same age, and calculated body fat index) reflected considerable number of cases of overweight and obesity among Abha women particularly at advanced ages. Under-weight was more relevant among women of younger ages. The study reported cases of high blood sugar particularly at older ages. Feeling of considerable improvement, participants showed great appreciation to the program and asked to be continuous. This study showed the effectiveness of the designed program in improving nutrition awareness among Saudi women particularly through group discussion. It was concluded that nutrition awareness of Saudi women can be improved through providing a simple, condensed and interactive nutrition workshops. Great efforts should be directed towards providing health and nutrition awareness programs among Saudi women particularly those at younger ages. The author recommends including nutrition awareness within school curricula at different ages.

***Key words:*** nutrition, education workshop, anthropometry, Saudi women, BMI, body weight, blood sugar

### Introduction

Malnutrition can be defined as either having less adequate or excess nutrients. Recent studies documented the increasing prevalence of overweight and obesity among Saudi populations (Al-Nozha *et al*., 2005; Al-Hazzaa, 2007). This was attributed to changes in eating habits (Al-Rethaiaa *et al*., 2010) which was the result of rapid cultural and social changes (Al-Nuaim *et al*., 1997; Alsaif *et al*., 2002; Amin *et al*., 2008).

The increased prevalence of obesity has been well documented among Saudi Arabia population in all age groups, thereby modification of current life style must be considered in order to reduce such danger through health and nutrition intervention programs (Al-Othaimeen *et al*., 2007).

The prevalence and trends of overweight, obesity and nutrition-related non-communicable diseases were studied in the Arabian Gulf States (Ng *et al*., 2011). Also, obesity and overweight are associated with a number of health problems such as diabetes mellitus, coronary artery disease, hypertension and stroke (Al-Nozha *et al*., 2005). Levels of diseases such as hypertension and diabetes were very high and increases with age. High rate of increase in obesity was reported for Saudi Arabia and Kuwait (Ng *et al*., 2011).

It was reported that consumption of refined foods and animal products has increased in Saudi diet on the expense of fruits and vegetables consumption (Amin *et al*., 2008; Mahfouz *et al*., 2007). Previous studies indicated the effectiveness of weight control using effective dietary plans; thereby, it can be useful to reduce the health hazards associated with obesity and overweight (Al-Nozha *et al*., 2005).

Women being responsible for preparing and introducing food for the household can affect the nutrition status and health of the whole family. Improving women's awareness will have great impact on health, performance and growth of the entire family. Preventive rather than curative measurers should be considered

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through cost effective nutrition intervention programs (Musaiger *et al*., 2011). Women nutrition knowledge was positively correlated with level of received education (Mansour and Hassan, 1994). The prevalence overweight and obesity was connected with the physical inactivity among Saudis aged 40-49 years of age (Alsaif *et al*., 2002; Al-Nozha *et al*., 2007). Thereby, personal physical activity should also be considered when planning nutrition and health awareness education programs.

This study aimed to evaluate the effectiveness of providing nutrition education program to groups of women in Abha city, and to evaluate the anthropometric measurements, readings of blood sugars before and after the education program.

## Materials and Methods

*Experimental design and sample selection:*

The ethical clearance and approval to conduct was obtained from the College of Medicine Ethical Committee at King Khalid University (KKU). Before participation, a signed consent from the participant was obtained after explaining the research project, its purpose and time-table. The subject was free to withdraw from the program at any time without notification. Women at different locations in Abha city were asked for participation. The data were collected at three schools, Girls' University center, College of Administration and Home Economics, and Abha General Hospital. Targeted sample size was 500 women, nevertheless, about 360 participants completed the programs.

*Anthropometric measurements and calculations:*

Anthropometric measurements were collected before and after providing five consequent nutrition education workshops. Weight in kg was measured using a personal scale Model EB9008 Glass Electronic from DH Top Health to the nearest 0.1 kg. Height, head circumference (HC), and mid arm circumference (MAC) were measured in cm using a standard plastic tap. Triceps skin fold thickness (TSF) was measured in mm using a 0-150 mm Vernier Caliper to the nearest mm.

Calculations were made as follows:

Body mass index (BMI) kg/ $m^2$ = weight (kg) / height$^2$ ($m^2$)

Weight as percentage of ideal (%)= 100 x weight (kg) / (ideal weight for the same age)

These equations were used to calculate fat mass index for women (Khalid, 1995):

Density = 1.1278 – [0.0775 x $\log_{10}$ (TSF mm)].

Body fat (%) = [(4.95 / density) – 4.5] x 100 .

Fat mass (kg) = weight (kg) x body fat percent / 100 .

Fat mass index = Fat mass (kg) / (height (cm) / 100)$^2$ .

BMI was categorized into five groups (<20, 20-<25, 25-<35, 35 - <40, and => 40 kg/$m^2$).

Age was categorized into five groups (<18, 18-<25, 25-<35 , 35-<40 , and 40-55 years).

Weight as percentage of ideal was categorized into four groups (under weight =< 90 %, normal = 90-110%, overweight = 110 – 130% and sever overweight =>130%).

*Recording blood sugar and hemoglobin readings:*

Participants were asked to supply their blood sugar and hemoglobin readings made at their nearest clinic and get reimbursed. Otherwise, blood sugar of the participant was measured in mg/dl using CONTOR® Meter from BAYER® provided with test strips and disposable sterile silicon coated lancets from BAYER Health Care (Poland). Participants were free to use the CONTOR meter with/without assistance or supply a reading of their blood sugar made at a nearest clinic to them. Sugar reading status of the participant was recorded as fasting or non-fasting. Received readings for hemoglobin were discarded because only a few participants supplied their readings.

According to the American Diabetes Association (ADA, 2011) clinical practice recommend-ation criteria for the diagnosis of diabetes fasting blood glucose (FBG) was categorized into four groups (low = <70, normal = 70 – 100, at risk = 100-125 and diabetic = > 125 mg/dl); whereas non-fasting blood glucose was categorized into four groups (low = <100, normal = 100 – 140, at risk = 140 – 199 and diabetic = > 200 mg/dl).

*Evaluation of subject's nutrition information and practice:*

A pre-designed pre-tested questionnaire was used to measure subject's sound nutrition knowledge (18 questions) and practice (12 questions). Subject's responses collected before and after the nutrition education workshops were calculated as percentages of correct answers to the nutrition knowledge and practice questions.

**Statistical analyses**: Statistical analyses were performed using the Statistical Package for Social Science (SPSS Inc., Chicago, IL) v.11.5. Student t-test was performed between pairs of means such as before and after

the education workshops. Tukey's Honestly Significant Difference was used as post hoc test for comparisons among means of the categories. Cross tables were performed between categorized variables in order to measure the power of their association using the $\chi^2$ test.

## Results and Discussion

The anthropometric measurements and calculated body fat parameters are summarized in table (1). The participants' age ranged from 12.0 to 55 years with a mean value of 27.1 year. Participants' weight ranged from 27-162 kg with an average weight of 65.2 kg. Participants' weight expressed as percent of ideal weight ranged from 58.7% to 257.1% with an average 109.9%. Participants' height as percentage of ideal height ranged from 68.7 to 104 cm, ie. it showed less variation than of participants' weight as % of ideal. The calculated arm muscle circumference (AMC) ranged from 2.28 to 50.41 cm with a mean value of 23.88 cm. Women calculated body showed wide variation among participants. Body fat index showed a range of 0.48- 22.27 with an average of 7.4.

**Table 1:** Anthropometric measurements of women participants and their calculated body fat parameters.

| Attribute | N | Mean | Std. Deviation | Minimum | Maximum | Percentiles | | |
|---|---|---|---|---|---|---|---|---|
| | | | | | | 5 | 50 | 95 |
| Age (year) | 360 | 27.1 | 10.0 | 12.0 | 55.0 | 14.0 | 26.0 | 42.0 |
| Weight (Kg) | 360 | 65.2 | 18.2 | 27.0 | 162.0 | 40.0 | 64.0 | 96.6 |
| Height (cm) | 360 | 154.6 | 6.0 | 112.0 | 170.0 | 145.1 | 155.0 | 164.0 |
| Head circumference (cm) | 330 | 53.5 | 3.8 | 31.0 | 74.0 | 50.3 | 54.0 | 58.0 |
| Triceps skin fold (TSF cm) | 328 | 15.4 | 7.4 | 3.0 | 58.0 | 5.0 | 15.0 | 29.0 |
| Mid arm circumference (cm) | 329 | 28.7 | 6.1 | 9.5 | 57.0 | 21.0 | 28.0 | 39.0 |
| Arm muscle circumference (cm) | 316 | 23.9 | 5.4 | 2.3 | 50.4 | 17.3 | 23.3 | 32.1 |
| weight as % of ideal | 360 | 109.9 | 27.0 | 58.7 | 257.1 | 72.7 | 106.0 | 160.2 |
| Height as % of ideal | 360 | 95.0 | 3.6 | 68.7 | 104.5 | 89.6 | 95.1 | 101.2 |
| Body Mass Index (BMI) | 360 | 27.3 | 7.4 | 12.6 | 58.6 | 17.5 | 26.4 | 40.9 |
| Body density | 328 | 1.04 | 0.017 | 0.99 | 1.09 | 1.01 | 1.04 | 1.07 |
| Body fat percent | 328 | 26.2 | 7.8 | 3.79 | 49.43 | 11.05 | 27.50 | 37.94 |
| Fat mass (Kg) | 328 | 17.8 | 8.8 | 1.17 | 65.66 | 4.42 | 16.95 | 32.91 |
| Fat mass index | 328 | 7.4 | 3.6 | 0.48 | 22.72 | 2.00 | 7.01 | 13.46 |

Table (2) presents the anthropometric and calculated measurements distributed according to age categories. Significant differences ($\boldsymbol{P} \geq 0.001$) were found among participants' age groups for all attributes except height, height as % of ideal and head circumference. It can be noticed from table (2) that as participant age increased a continuous increase was found for weight, weight as % of ideal, arm circumference, triceps skinfold thickness, BMI, arm circumference and fat mass index. On the contrary, body density decreased as participants' age increased. This indicated that deposition of fat increases as participants become older. Al-Othaimeen *et al*., (2007) reported lower values for Saudi women weight and height at similar age categories according to a 3-year national survey.

Table (3) presents the anthropometric measurements distributed according to weight as % of ideal categories. All attributes showed significant differences ($P \geq 0.001$) among groups of participants' weight expressed as % of ideal. All attributes showed a continuous increase as weight increased except for body density which decreased as weight as % of ideal increased. This is expected because of the increased deposited fat has less density than other body constituents. Al-Othaimeen *et al*., (2007) noticed significant increase in the prevalence of overweight and obesity (BMI $\geq$ 25 kg/m$^2$) for Saudi males and females with age.

*Blood sugar levels:*

Non-fasting (arbitrary) or fasting blood sugar (NFBS, FBS; respectively) readings of participants were recorded before and after providing the workshops. The first group of participants recorded FBS before and after the workshops (Table 4), the second group recorded NFBS before and after the workshops (Table, 5), and the third group recorded FBS and NFBS before and after the workshops (Table, 6). Data in table (4) showed significant differences among means (LSD at $\boldsymbol{P} \geq 0.05$) of FBS of age groups with the age category 40-55 year having the highest FBS of all. Comparisons between average readings of FBS before and after the workshops showed no significant difference except for the youngest age category (<18 year).

**Table 2:** Anthropometric and calculated measurements that distributed according to age categories.

| Descriptive | | Age categories (years) | | | | | Total | *Prob-ability* |
|---|---|---|---|---|---|---|---|---|
| | | <18 | 18-<25 | 25-<35 | 35-<40 | 40 - 55 | | |
| | | | | | | | | |
| | N | 94 | 79 | 74 | 75 | 38 | 360 | |
| Weight (kg) | Mean* | 52.4 C | 59.7 C | 70.4 B | 74.9 AB | 79.4 A | 65.2 | 0.001 |
| | St. D[a]. | 14.1 | 14.5 | 16.3 | 15.0 | 19.1 | 18.2 | |
| | | | | | | | | |
| Height (cm) | Mean* | 153.6 A | 155.7 A | 154.7 A | 154.4 A | 154.6 A | 154.6 | 0.239 |
| | St. D. | 5.1 | 5.6 | 7.9 | 5.1 | 5.7 | 6.0 | |
| | | | | | | | | |
| Weight as % of ideal | Mean* | 99.9 C | 104.0 C | 111.7 BC | 118.8 AB | 125.7 A | 109.9 | 0.001 |
| | St. D. | 25.4 | 25.2 | 25.9 | 23.8 | 30.2 | 27.0 | |
| | | | | | | | | |
| Height as % of ideal | Mean* | 95.2 A | 95.1 A | 94.9 A | 94.7 A | 95.0 A | 95.0 | 0.923 |
| | St. D. | 3.2 | 3.4 | 4.9 | 3.1 | 3.5 | 3.6 | |
| | | | | | | | | |
| Body mass index | Mean* | 22.1 C | 24.6 C | 29.5 B | 31.4 AB | 33.2 A | 27.3 | 0.001 |
| | St. D. | 5.5 | 5.5 | 6.9 | 6.4 | 7.2 | 7.4 | |
| | | | | | | | | |
| | N | 87 | 72 | 65 | 68 | 36 | 328 | |
| Head circumference (cm) | Mean* | 52.8 A | 54.0 A | 53.5 A | 53.5 A | 54.6 A | 53.5 | 0.106 |
| | St. D. | 2.2 | 2.7 | 4.2 | 5.8 | 1.8 | 3.8 | |
| | | | | | | | | |
| Arm circumference (cm) | Mean* | 25.5 C | 27.4 BC | 29.5 AB | 31.8 A | 31.6 A | 28.7 | 0.001 |
| | St. D. | 4.7 | 5.5 | 5.1 | 6.6 | 6.4 | 6.1 | |
| | | | | | | | | |
| Triceps skin fold (mm) | Mean* | 11.0 C | 14.6 B | 17.0 B | 17.6 AB | 20.6 A | 15.4 | 0.001 |
| | St. D. | 6.9 | 6.4 | 7.1 | 5.4 | 8.7 | 7.4 | |
| | | | | | | | | |
| Arm muscle circumference (cm) | Mean* | 22.1 B | 22.9 B | 24.1 AB | 26.2 A | 25.6 A | 23.9 | 0.001 |
| | St. D. | 3.8 | 5.2 | 4.7 | 6.2 | 6.4 | 5.4 | |
| | | | | | | | | |
| Density (kg/m$^3$) | Mean* | 1.052 A | 1.041 B | 1.036 BC | 1.033 C | 1.029 C | 1.040 | 0.001 |
| | St. D. | 0.018 | 0.016 | 0.015 | 0.011 | 0.015 | 0.017 | |
| | | | | | | | | |
| Body fat % | Mean* | 20.7 C | 25.6 B | 28.1 AB | 29.3 A | 31.2 A | 26.2 | 0.001 |
| | St. D. | 7.9 | 7.2 | 6.8 | 5.2 | 6.9 | 7.8 | |
| | | | | | | | | |
| Fat mass index | Mean* | 4.8 D | 6.4 C | 8.5 B | 9.4 AB | 10.4 A | 7.4 | 0.001 |
| | St. D. | 2.6 | 2.7 | 3.3 | 3.0 | 3.6 | 3.6 | |
| [a] St.D. = Standard deviation. | | | | | | | | |
| * Means sharing the same alphabetical character(s) are not significantly different at $P \leq 0.05$. | | | | | | | | |

**Table 3:** Anthropometric measurements distributed according to weight as % of ideal categories.

| Characteristics | | Weight as % of ideal categories | | | | Total | *Prob-ability* |
|---|---|---|---|---|---|---|---|
| | | < 90% | 90 - 110% | 110 - 130% | > 130% | | |
| | | | | | | | |
| | N | 87 | 106 | 56 | 111 | 360 | |
| Age (year) | Mean* | 21.3 C | 26.3 B | 30.2 A | 30.8 A | 27.1 | 0.001 |
| | St. D[a]. | 7.6 | 9.5 | 9.5 | 10.3 | 10.0 | |
| | | | | | | | |
| Height (cm) | Mean* | 152.0 B | 154.7 A | 155.8 A | 155.8 A | 154.6 | 0.001 |
| | St. D. | 5.3 | 6.5 | 4.4 | 6.1 | 6.0 | |
| | | | | | | | |
| Weight as % of ideal | Mean* | 79.6 D | 99.2 C | 114.8 B | 141.3 A | 109.9 | 0.001 |
| | St. D. | 7.5 | 5.4 | 3.0 | 21.5 | 27.0 | |
| | | | | | | | |
| Height as % of ideal | Mean* | 93.5 B | 95.0 A | 95.6 A | 95.8 A | 95.0 | 0.001 |
| | St. D. | 3.2 | 4.0 | 2.7 | 3.7 | 3.6 | |
| | | | | | | | |
| Body mass index | Mean* | 19.6 D | 24.6 C | 28.7 B | 35.2 A | 27.3 | 0.001 |
| | St. D. | 2.9 | 3.8 | 2.6 | 6.2 | 7.4 | |
| | | | | | | | |
| | N | 81 | 95 | 51 | 101 | 328 | |
| Head circumference (cm) | Mean* | 52.0 B | 53.5 AB | 54.5 A | 54.3 A | 53.5 | 0.001 |
| | St. D. | 3.7 | 2.9 | 1.8 | 4.8 | 3.8 | |
| | | | | | | | |
| Arm circumference (cm) | Mean* | 23.9 D | 26.6 C | 29.2 B | 34.3 A | 28.7 | 0.001 |
| | St. D. | 4.3 | 2.6 | 4.7 | 5.8 | 6.1 | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Triceps skinfold (mm) | Mean* | 10.8 C | 14.9 B | 16.4 AB | 19.1 A | 15.4 | 0.001 |
| | St. D. | 6.0 | 7.4 | 7.1 | 6.6 | 7.4 | |
| | | | | | | | |
| Arm muscle circumference (cm) | Mean* | 20.5 C | 22.0 BC | 23.9 B | 28.4 A | 23.9 | 0.001 |
| | St. D. | 4.2 | 2.7 | 4.9 | 5.3 | 5.4 | |
| | | | | | | | |
| Density (kg/m3) | Mean* | 1.052 A | 1.041 B | 1.036 BC | 1.031 C | 1.0 | 0.001 |
| | St. D. | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | |
| | | | | | | | |
| Body fat % | Mean* | 20.5 C | 25.8 B | 27.7 AB | 30.3 A | 26.2 | 0.001 |
| | St. D. | 7.9 | 7.2 | 6.5 | 6.0 | 7.8 | |
| | | | | | | | |
| Fat mass (kg) | Mean* | 9.5 D | 15.2 C | 19.3 B | 26.2 A | 17.8 | 0.001 |
| | St. D. | 4.1 | 5.0 | 5.1 | 8.2 | 8.8 | |
| | | | | | | | |
| Fat mass index | Mean* | 4.11 D | 6.40 C | 7.93 B | 10.84 A | 7.4 | 0.001 |
| | St. D. | 1.8 | 2.2 | 2.1 | 3.3 | 3.6 | |
| [a] St.D. = Standard deviation. | | | | | | | |
| * Means sharing the same alphabetical character(s) are not significantly different at $P \leq 0.05$. | | | | | | | |

**Table 4:** Fasting blood sugar (FBS) of participants before and after nutrition education workshops (Number of pairs = 89).

| Age category | N | Before workshop | | After workshop | | t-value | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|
| | | Mean* | Std. Deviation | Mean* | Std. Deviation | | |
| <18 yr | 13 | 91.8 B | 26.6 | 83.8 BC | 15.5 | 2.355 | 0.036 |
| 18-<25 yr | 32 | 80.4 C | 10.6 | 78.9 C | 7.1 | 1.267 | 0.215 |
| 25-<35 yr | 15 | 91.7 B | 25.4 | 91.3 B | 26.3 | 0.261 | 0.798 |
| 35-<40 yr | 15 | 81.3 C | 10.1 | 89.5 B | 18.7 | -1.690 | 0.113 |
| 40 - 55 yr | 14 | 102.4 A | 19.2 | 107.0 A | 35.1 | -0.426 | 0.677 |

$LSD_{0.05}$ = 9.505. N = number of participants within the age group. Std. Deviation = Standard deviation.
* Age group means sharing same alphabetical character(s) are not significantly different ($P \geq 0.05$)

Data in table (5) showed significant differences among age categories in which the elder categories 35- <40 and 40- 55 year had higher NBS than the other age categories. No significant differences were found (t-test) between pairs of average NBS readings before and after the workshops for each age category.

**Table 5:** Non-fasting blood sugar (NFBS) of participants before and after nutrition education workshops (Number of pairs = 101).

| Age category | N | Before workshop | | After workshop | | t-value | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|
| | | Mean* | Std. Deviation | Mean* | Std. Deviation | | |
| <18 yr | 41 | 85.9 B | 16.7 | 89.0 B | 15.9 | -0.895 | 0.376 |
| 18-<25 yr | 15 | 84.4 B | 15.4 | 89.1 B | 22.5 | -0.893 | 0.387 |
| 25-<35 yr | 14 | 91.3 B | 15.9 | 93.9 B | 13.8 | -0.724 | 0.482 |
| 35-<40 yr | 21 | 107.6 A | 23.4 | 105.4 A | 24.4 | 0.629 | 0.537 |
| 40 - 55 yr | 10 | 101.5 A | 19.5 | 103.7 A | 21.2 | -0.438 | 0.671 |

$LSD_{0.05}$ = 9.261. N = number of participants within the age group. Std. Deviation = Standard deviation.
* Age group means sharing same alphabetical character(s) are not significantly different ($P \geq 0.05$)

Data in table (6) show the comparisons among participants with respect to FBS and ABS. The elderly age category; 40-55 year showed significantly the highest FBS and ABS among participants compared with younger age categories. This confirms that blood sugar increases as women advances in age.

**Table 6:** Fasting (FBS) versus non-fasting (NFBS) blood sugar of participants before and after workshop (Number of pairs = 122).

| Age category | N | Fasting blood sugar | | Non-Fasting blood sugar | | t-value | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|
| | | Mean* | Std. Deviation | Mean* | Std. Deviation | | |
| <18 yr | 35 | 78.5 C | 8.5 | 82.3 C | 12.6 | -1.926 | 0.062 |
| 18-<25 yr | 19 | 79.7 C | 10.2 | 82.1 C | 11.1 | -1.050 | 0.307 |
| 25-<35 yr | 27 | 87.4 BC | 13.3 | 94.8 B | 20.6 | -2.468 | 0.020 |
| 35-<40 yr | 29 | 92.1 B | 17.6 | 96.4 B | 20.8 | -1.302 | 0.204 |
| 40 - 55 yr | 12 | 116.1 A | 48.5 | 113.8 A | 54.6 | 0.348 | 0.734 |

$LSD_{0.05}$ = 9.215. N = number of participants within the age group. Std. Deviation = Standard deviation.
* Age group means sharing same alphabetical character(s) are not significantly different ($P \geq 0.05$)

*Participants' responses to the nutrition information and practice questionnaire:*

Participants' responses (calculated as percentage of correct answers to the asked questions) are summarized in table (7). Improvements in participants' knowledge were evident. Comparison between scores before and after workshops (t-test) showed significant differences. It is obvious from table (7) that participants having younger age (<18 year category) recorded the least scores among other age categories for both information and practice questions. These results reflect the necessity for younger women to improve their nutrition awareness. Meanwhile, their after workshops scores were significantly higher than before workshops compared with scores of older age categories. This reflects the fact that the improvement associated with younger age categories was better than with other age categories.

A previous study (Mansour and Hassan, 1994) evaluated the factors that influence women's nutrition knowledge in Saudi Arabia. The authors found that the majority of women had poor nutrition knowledge. Knowledge score was positively correlated with education level and negatively with numbers of pregnancies, deliveries, and living children. Women and children are vulnerable groups due to the special characteristics associated with their growth and development (Mansour and Hassan, 1994).

Comparisons among participants according to their blood sugar categories and weight (expressed as % of ideal weight) categories or BMI categories before and after the nutrition workshops were depicted in figures 1, 2, 3 and 4). Figure (1) represents the comparison among participants according to their weight groups before and after the nutrition workshops

**Table 7:** Participants' scores (calculated as % of correct answers) of general nutrition information and good practice questions before and after nutrition education workshop.

| Type of questions | Age groups | N | Before and after introducing nutrition education workshops | | | | t-value | ***P*** |
|---|---|---|---|---|---|---|---|---|
| | | | Before | | After | | | Sig. (2-tailed) |
| | | | Mean* | Std. Deviation | Mean* | Std. Deviation | | |
| Nutrition Information questions | | | | | | | | |
| | <18 yr | 94 | 49.5 C | 23.2 | 66.0 C | 24.8 | -5.08 | 0.000 |
| | 18-<25 yr | 76 | 62.5 B | 21.3 | 86.1 A | 17.8 | -7.68 | 0.000 |
| | 25-<35 yr | 69 | 71.0 A | 19.0 | 79.0 B | 18.5 | -2.64 | 0.010 |
| | 35-<40 yr | 70 | 64.4 B | 24.9 | 73.5 B | 26.1 | -2.35 | 0.021 |
| | 40 - 55 yr | 38 | 70.2 A | 21.4 | 77.9 B | 22.8 | -1.93 | 0.061 |
| | | | $LSD_{0.05}$ = 5.54 | | | | | |
| Good Practice questions | | | | | | | | |
| | <18 yr | 94 | 51.7 C | 26.7 | 59.9 C | 23.5 | -2.64 | 0.010 |
| | 18-<25 yr | 76 | 62.6 B | 23.9 | 76.1 A | 16.9 | -4.19 | 0.000 |
| | 25-<35 yr | 69 | 71.9 A | 19.1 | 74.1 A | 19.7 | -0.86 | 0.393 |
| | 35-<40 yr | 70 | 67.0 AB | 28.2 | 67.8 B | 24.5 | -0.14 | 0.887 |
| | 40 - 55 yr | 38 | 69.3 A | 24.3 | 72.8 AB | 23.5 | -1.00 | 0.326 |
| | | | $LSD_{0.05}$ = 5.77 | | | | | |
| Total asked questions | | | | | | | | |
| | <18 yr | 94 | 50.4 D | 23.3 | 63.5 D | 23.1 | -4.30 | 0.000 |
| | 18-<25 yr | 76 | 62.5 C | 20.7 | 82.1 A | 16.0 | -6.70 | 0.000 |
| | 25-<35 yr | 69 | 71.4 A | 17.7 | 77.1 AB | 17.7 | -2.12 | 0.038 |
| | 35-<40 yr | 70 | 65.5 BC | 25.1 | 71.2 C | 24.9 | -1.46 | 0.149 |
| | 40 - 55 yr | 38 | 69.8 AB | 22.0 | 75.9 BC | 21.7 | -1.69 | 0.099 |
| | | | $LSD_{0.05}$ = 5.35 | | | | | |

N = number of participants within the age group. Std. Deviation = Standard deviation.

* Age group means sharing same alphabetical character(s) are not significantly different (***P***≥0.05).

with respect to their fasting blood sugar categories. Fasting blood sugar was shifted towards normal level (70-100 mg/dl from other categories. It was calculated that the percentage of all participants having normal fasting blood sugar was 77% before the nutrition workshops which increased to 84.1% of total participants after the workshops. It should be mentioned that the under weight group (<90% of ideal weight) of all participants decreased from 24.8 of total to 18.6 of total participant which reflected improvement in their weight. Chi square test reflected significant association between fasting blood sugar and weight % both before ($\chi^2$ = 18.071; ***P*** = 0.034) and after ($\chi^2$ = 21.513; ***P*** = 0.011) the workshop.

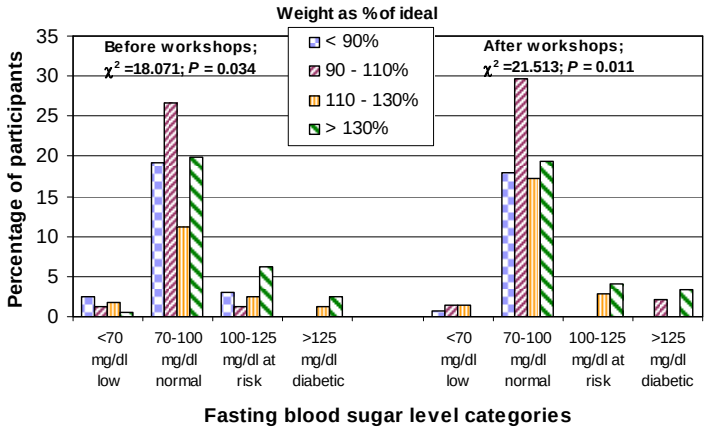


**Fig. 1:** Percentage of participants according to their Fasting blood level categories and weight as % of ideal categories before and after nutrition education workshops.

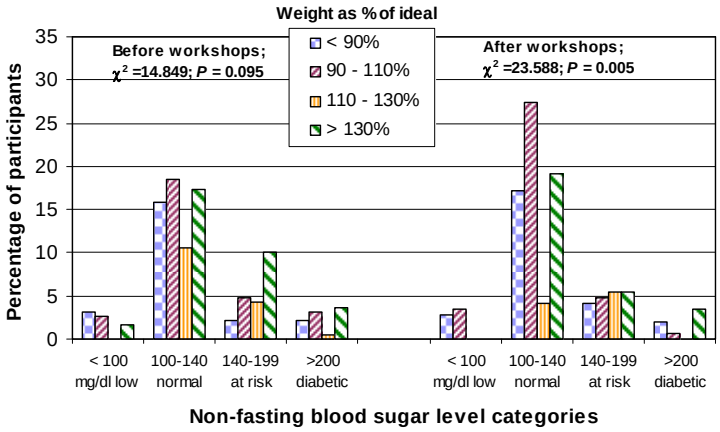


**Fig. 2:** Percentage of participants according to their non-Fasting blood level categories and weight as % of ideal categories before and after nutrition education workshops.

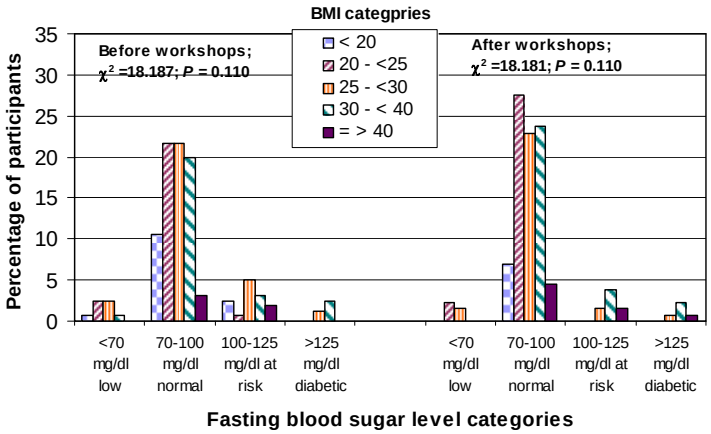


**Fig. 4:** Percentage of participants according to their Fasting blood level categories and Body Mass Index (BMI) categories before and after nutrition education workshops.

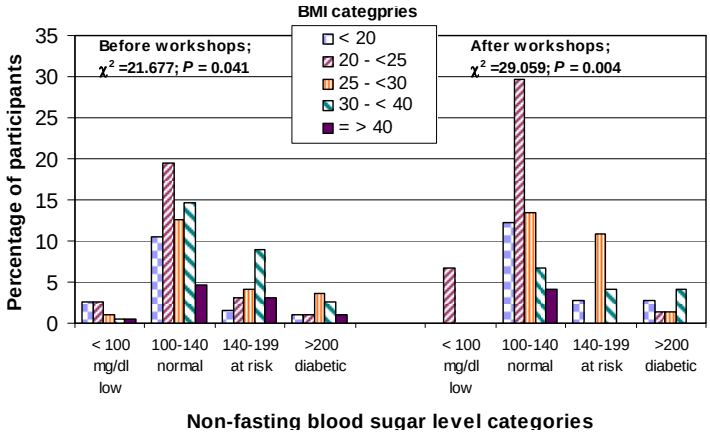


**Fig. 4:** Percentage of participants according to their non-Fasting blood level categories and Body Mass Index (BMI) categories before and after nutrition education workshops.

Similar trends were also noticeable from figure (2) for non-fasting blood sugar. Chi square test reflected highly significant association between non-fasting blood sugar and weight % of ideal weight only for after the workshop ($\chi^2$ = 23.588; ***P*** = 0.005). It was calculated that the category of normal non-fasting blood sugar category (100-140 mg/dl) for the normal weight % category (90 – 110%) showed an increase from 18.4% before the workshops to 27.4% after the workshops, and that category of normal weight increased form 28.9% to 36.3 of all participants before and after the workshops, respectively. This indicated that participants showed quit acceptable response and improvements in their weight and blood sugar levels regardless the short time duration of the education program (two months).

Figures (3 and 4) represent the comparison among participants according to their BMI categories with respect to fasting and non-fasting blood sugar, respectively. Percentage of participants having normal fasting blood sugar (70 – 100 mg/dl) increased from 21.7% before the workshops to 27.5% after the workshops for the normal BMI category (20- <25 kg/m$^2$), and from 19.9% to 23.7 for the BMI category (30-<40 kg/m$^2$). For non-fasting blood sugar and BMI categories (Figure 4), Chi square test reflected significant association between non-fasting blood sugar and BMI categories both before ($\chi^2$ = 21.677; ***P*** = 0.041) and after ($\chi^2$ = 29.059; ***P*** = 0.004) the workshop.

Because weight as % of ideal and BMI are both calculated form participant weight kg, it can be concluded that improving body weight through nutrition awareness "diet watching" will have great impact on both fasting and non-fasting blood sugar levels. Body weight can be easily and regularly monitored using a personal foot balance. Al-Nozha *et al*., (2007) studied the prevalence of physical activity and inactivity among Saudis. The authors found high prevalence of inactivity among Saudis which represents a major public health concern because of the sedentary nature of Saudi population.

*Conclusion:*

It can be concluded from the present study that nutrition education of women in groups when providing workshops with open discussion proved as a valuable tool to improve women awareness of nutrition knowledge and practice, and to reduce overweight and obesity; a major risk factor for many health complications.

Woman nutrition awareness assures food security within the family through wise selection of food (economically and nutritionally), correct eating habits, and fulfill each individual needs within the family.

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