Research Article
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# Prevalence of anemia and its association with random blood glucose levels and anthropometric indices in the Saudi female population

## Abstract

**Objectives:** The present study aims to study the prevalence and association of anemia with random blood glucose levels and other anthropometric indices in a sample of young female students from the University of Hail (UOH) in Hail City, KSA.

**Methodology**: A sample of 400 female college students was enrolled and body composition was measured by using the bioelectrical impendence technique. Random blood glucose levels (RCBG) were measured using One Touch® Ultra® (Lifescan Johnson & Johnson, Milpitas, USA). The study population was divided into two RCBG groups: low RCBG group (<110 mg/dl) and high RCBG group (>110 mg/dl) and Hb: normal Hb group (> 12 g/dl) and anemic group (<12 mg/dl). Pearson correlation, chi-square analysis, and linear regression analysis were used to examine associations between variables. T-test was used to check to mean differences.

**Results**: Around 79 percent of the study population were having low RCBG (<110 mg/dl) while 21 percent were observed to have high RCBG (>110 mg/dl). Around 69 percent of the study population were having normal Hb levels while 31 percent were observed to have anemia as defined by low Hb levels. T–test results indicate that there are significant differences in mean values for all studied anthropometric variables, RCBG with HB groups. The mean RCBG value was significantly higher for the anemia group as compared to the Normal Hb group. Pearson correlation indicated the associations for Hb were positive and highly significant for studied anthropometric variables while the relationship with RCBG was significantly negative. Odd's ratio indicated that there is a higher risk of 1.8 times for the anemic group to have high RCBG as compared to the normal Hb group. In linear regression analysis, for RCBG values, Hb and Haemaetocrit explained 14.1 % of the variance; while Hb, Haemaetocrit, and Visceral fat together explained 15.7 % of the variance.

**Conclusion:** In the present study, Hemoglobin and hematocrit were identified as useful tools in predicting risk for diabetes even in the young Saudi female population. Diabetes and anemia relationship could be casual. However, future studies with larger sample sizes are required to obtain more conclusive results.

**Keywords:** anemia, diabetes, hemoglobin, nutrition, random blood glucose

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## Introduction

Nutritional anemia is the most common disorder globally affecting 24.8 % of the population.[1,2] Specifically, iron deficiency anemia is prevalent in both developing and developed countries.[3] Anemia is a condition, "characterized by a reduction in the red blood cell volume or decrease in the concentration of hemoglobin (Hb) in the blood".[4] Haemoglobin, the protein present in red blood cells, is the chief carrier of oxygen to various body parts and cells. There are various stages of anemia and stage IV is the more severe form in which hemoglobin concentration falls below a statistically defined threshold. Anaemia could be a result of acute malnutrition or a chronic condition. Anaemia is known to contribute "significantly to morbidity, causing symptoms such as lack of energy, breathlessness, dizziness, poor appetite, reduced cognitive function, and reduced exercise tolerance".[5] Anaemia is a common complication type 2 diabetic population.[5] Diabetes is a chronic disease and because of its association with blood glucose levels impacts the quality of life for the affected population. Anaemia presence along with diabetes could further complicate life by compromising energy levels and increasing fatigue levels. Further anemia increases the risks of adverse outcomes like diabetic nephropathy and chronic renal failure for the diabetic population.[5,6] In addition, anemia itself may contribute to the development and progression of micro- and macrovascular complications of diabetes. Despite these facts, there are very few studies that have examined the association of anemia in normal healthy populations with increased levels of blood glucose. Random blood glucose levels are recently being recognized as a useful community screening tool for identifying people with future diabetic risk.[7,8] Early detection is highly important in the case of diabetes since a majority of diabetic people recognize the disease only after developing the complications.[9] The present study, therefore, was taken up to study the prevalence and association of anemia with random blood glucose levels and other anthropometric indices.

### Significance of the present study

There are no studies from Saudi Arabia investigating the relationship of anemia with random blood glucose values in the healthy population. The potential advantage of doing this study is that both hemoglobin and random blood glucose levels can be effectively used as community screening tools to identify people with future diabetic risk. The information generated will help reduce the medical costs involved in screening the entire population for diabetes risk.

# Methodology

## Study design

A cross-sectional survey was planned and conducted on the female campus of the University of Hail, Hail, KSA during Sep. 2021 to Nov. 2021.

## Sample

Approximately, a random sample size of 400 female students (representing both Science and Humanities Colleges) participated in the survey. Posters were pasted throughout college informing the days of data collection and all healthy subjects who visited labs were included in the study. Exclusion criteria followed included females with pregnancy, lactation, and menstruation cycle during examining days and known chronic diseases.

## Ethics

All enrolled participants were briefed about the purpose of the study and were required to provide written informed consent before participating in the study. The study protocol was approved by the University of Hail's Deanship of Scientific Research.

## Data collection methods

For body composition analysis, subjects were to undergo bioelectric impedance analysis (BioSpace, Inbody 720) for anthropometric measurements. The manufacturer's instructions were followed strictly for accurate measurement with In Body 720. Body mass index (BMI) was calculated as "weight in kilograms divided by the square of standing height in meters". Overweight (25 and 29.9 kg/m$^2$) and obese (greater than 29.9 kg/m$^2$) are classified based on WHO international classification. Random blood glucose levels (RCBG) were measured using One Touch® Ultra® (Lifescan Johnson & Johnson, Milpitas, USA). Previous studies have suggested using RCBG>110 mg/dl as a cut-off point for going for definitive testing for diabetes.[8] Therefore the study population was divided into two groups based on this cut-off: the low RCBG group (<110 mg/dl) and the high RCBG group (>110 mg/dl).

## Statistical analysis

Statistical analyses were performed using the Statistical Package for Social Sciences (version 26.0, SPSS, Inc) software. Descriptive statistics such as means, and standard deviations were calculated for the continuous variables and frequencies for qualitative data. Results were expressed as either mean ±SD or counts and percentages. Pearson correlation, chi-square analysis, and linear regression analysis were used to examine associations between variables. T-test was done to test mean differences. All reported P values were 2-sided.

# Results

Statistical analysis for the study sample of 400 has been presented in this section. Table 1 presents the mean ± SD of anthropometric and body composition characteristics of subjects. The mean age of the study subjects was around 23 since most of the subjects who participated in the study were students. The mean height of the subjects was around 158 cm, and the mean weight was 64 kg. Mean BMI was in the overweight category (25.55) while BF% was in the high-risk range. The table also provides the mean values for waist circumference (WC), Hip circumference, Waist Hip Ratio (WHR), and Visceral Fat (VC) as measured by the inbody 720 machines. RCBG and hemoglobin (Hb) mean values were in a normal range. Figure 1 depicts BMI distribution in the study population. Accordingly, around 11 percent are underweight while 25 percent were overweight, and another 22 percent were obese. Only 42 percent of the study population had normal weight.

**Table 1** Baseline characteristics of the study population

| Anthropometric variables | Mean | Standard deviation |
|---|---|---|
| Age (yr) | 22.72 | 5.97 |
| Height (cm) | 158.12 | 5.109 |
| Weight (kg) | 63.93 | 16.31 |
| BMI (kg/m$^2$) | 25.55 | 6.28 |
| Percent Body Fat (%) | 38.44 | 8.98 |
| Waist Circumference (cm) | 86.92 | 15.36 |
| Hip circumference (cm) | 97.09 | 9.76 |
| Waist Hip Ratio (WC/HC) | 0.89 | 0.69 |
| Visceral Fat (cm) | 97.39 | 46.52 |
| RCBG (mg/dl) | 101.09 | 26.88 |
| Haemoglobin (g/dl) | 12.56 | 1.31 |
| Hematocrit (%) | 36.89 | 3.98 |

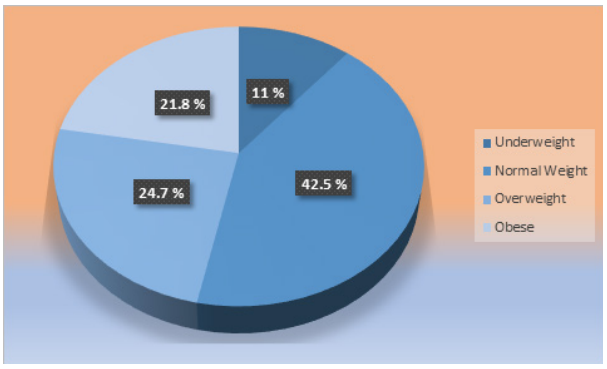


**Figure 1** Distribution of BMI groups in the study population.

Figure 2 shows the RCBG group distribution in the study population. Previous studies have suggested using RCBG >110 mg/dl as a cut-off point for going for definitive testing for diabetes.[8] Therefore, the study population was divided into two groups based on this cut-off: the low RCBG group (<110 mg/dl) and the high RCBG group (>110 mg/dl). Accordingly, around 79 percent of the study population were having low RCBG (<110 mg/dl) while 21 percent were observed to have high RCBG (>110 mg/dl) Figure 3. The study population was divided into two groups based on cut-off 12 g/dl: normal Hb group (>12 g/dl) and anemic group (<12 mg/dl). Accordingly, around 69 percent of the study population were having normal Hb levels while 31 percent were observed to have anemia as defined by low Hb levels.

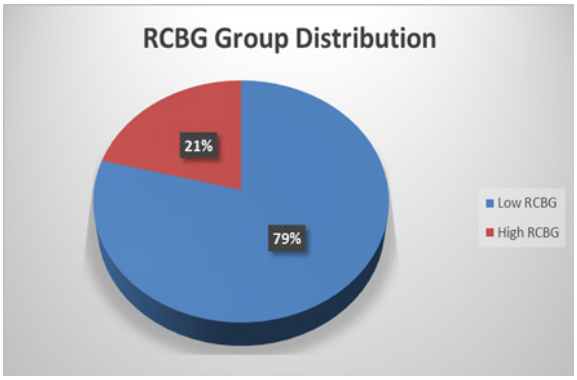


**Figure 2** Distribution of RCBG groups in the study population.

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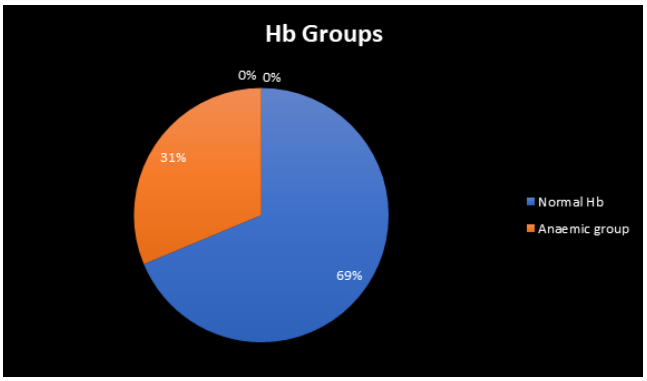


**Figure 3** shows the Hb group distribution in the study population.

Table 2 presents the mean differences for anthropometric variables and RCBG for Hb groups. T–test results indicate that there are significant differences in mean values for all studied anthropometric variables, RCBG with HB groups. The mean RCBG value was significantly higher for the anemia group as compared to the Normal Hb group. Table 3 presents the relationship between hemoglobin and hematocrit with studied anthropometric measurements and RCBG as tested by the Pearson correlation test. All the associations were positive and highly significant for anthropometric variables while the relationship with RCBG was significantly negative. Table 4 presents a chi-square analysis for RCBG groups with Hb groups (normal and anemic). Chi-square analysis is significant ($p<0.005$) and Odd's ratio indicated that there is a higher risk of 1.8 times for the anemic group to have high RCBG as compared to the normal Hb group. Table 5 presents stepwise regression analysis for RCBG as the dependent variable and anthropometric variables (BMI, %BF, WHR, WC, VF), Hb, and Haemaetocrit as independent variables. For RCBG, Hb and Haemaetocrit explained 14.1 % of the variance; while Hb, Haemaetocrit, and Visceral fat together explained 15.7 % of the variance. All other anthropometric variables were excluded from the model.

**Table 2** Mean differences for anthropometric variables and RCBG values for Hb groups (mean ± SD)

| Anthropometric variables | Normal Hb | Anaemia group | T-Value |
|---|---|---|---|
| BMI (kg/m$^2$) | 26.04 ± 6.18 | 25.16 ± 6.66 | 6.075 (P<0.001) |
| Percent Body Fat (%) | 39.58 ± 8.31 | 37.37 ±9.43 | 11.113 (P<0.001) |
| Waist Circumference (cm) | 88.59 ± 15.20 | 85.66 ± 16.05 | 8.232 (P<0.001) |
| Waist Hip Ratio (WC/HC) | 0.89 ± 0.67 | 0.88 ± 0.07 | 9.479 (P<0.001) |
| Visceral Fat (cm) | 103.27 ± 46.04 | 95.10 ± 45.75 | 8.232 (P<0.001) |
| RCBG (mg/dl) | 98.90 ± 29.90 | 103.31 ± 24.99 | 6.892 (P<0.001) |

**Table 3** Pearson correlations for hemoglobin and hematocrit with anthropometric and RCBG measurements

| Anthropometric variables | Pearson coefficient with Hb | Pearson coefficient with haemaetocrit |
|---|---|---|
| BMI (kg/m$^2$) | 0.108* | 0.073* |
| Percent Body Fat (%) | 0.187* | 0.166* |
| Waist Circumference (cm) | 0.124* | 0.084* |
| Waist Hip Ratio (WC/HC) | 0.131* | 0.089* |
| Visceral Fat (cm) | 0.122* | 0.074* |
| RCBG (mg/dl) | -0.075* | -0.255* |
| Hematocrit (%) | 0.911* | |
| Haemoglobin (g/dl) | | 0.911* |

**Table 4** Chi-square analysis for RCBG groups with Hb groups

| HB group * RCBGgroups Crosstabulation | | | | | | |
|---|---|---|---|---|---|---|
| **Hb groups** | | **RCBGgroups** | | **Total** | **Chi-Square** | **Odd's Ratio** |
| | | **Normal** | **High** | | | |
| Anemic group | Count | 95 | 30 | 125(31%) | 7.933 | 1.879 |
| | % within HB Group | 76.00% | 24.00% | 100.00% | (p= 0.005) | 95 % CI |
| Normal Hb | Count | 240 | 35 | 275 (69%) | | (1.211- 2.916) |
| | % within HB Group | 87.20% | 12.80% | 100.00% | | |
| Total | Count | 335 | 65 | 400 | | |
| | % within HB Group | 83.70% | 16.30% | 100.00% | | |

*$p<0.0001$

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**Table 5** Linear Regression analysis for RCBG with anthropometric variables and Hb and Hematocrit

| Coefficients | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Model** | | **Unstandardized Coefficients** | | **Standardized Coefficients** | **t** | **Sig.** | **R square** |
| | | **B** | **Std. Error** | **Beta** | | | |
| 1 | (Constant) | 148.939 | 11.305 | | 13.175 | 0 | 0.045 |
| | Hematocrit | -135.30% | 30.50% | -21.70% | -4.439 | 0 | |
| 2 | (Constant) | 128.281 | 11.199 | | 11.455 | 0 | 0.141 |
| | Hematocrit | -617.40% | 78.90% | -99.30% | -7.825 | 0 | |
| | Hb | 15.8 | 2.405 | 0.833 | 6.569 | 0 | |
| 3 | (Constant) | 12503.70% | 1117.00% | | 11.194 | 0 | 0.157 |
| | Hematocrit | -6.041 | 0.784 | -0.971 | -7.704 | 0 | |
| | Hb | 15.111 | 2.399 | 0.797 | 6.3 | 0 | |
| | visceral fat | 0.072 | 0.026 | 0.128 | 2.75 | 0.006 | |

a. Dependent Variable: Glucose

## Discussion

Worldwide obesity and diabetes are increasingly becoming major public health issues.[10,11] Saudi Arabia is no exception to these trends and has the highest prevalence rates for both obesity and diabetes.[12,13] According to the International diabetes federation, there were 3.6 million cases of diabetes in Saudi Arabia in 2013.[13] Prevention is the key and this should be done as early as possible given the adverse consequences and medical costs involved with diabetes management. Also, early detection is highly important in the case of diabetes since the majority of diabetic people recognize the disease only after developing complications.[9] Thus, clinical detection of individuals with increased risk for diabetes has become clinically very important. Studies from different parts of the world have reported the prevalence of anemia among patients with diabetes to be high, especially in developing countries. Results of our study were in accordance to one research results from Iran (among residents of Tehran city) in 2014 which was reported to be 30.4% (14). A recent analytical research concluded a prevalence of 35% for anemia among patients with T2DM in Africa (15). Contrary to the results of present study, some researchers from India and Australia showed a comparatively lower prevalence of 12.13% and 11.5%, respectively.[16,17]

In this study, we tried to examine to study the prevalence and association of anemia with random blood glucose levels and other anthropometric indices among young female participants. RCBG is a simple clinical marker that can be used relatively cheaply for detecting people with increased future diabetes risk.[8] The results from our study indicate that Hb and hematocrit are associated with RCBG levels and could explain variance better than traditional anthropometric measurements like BMI, WC, WHR, and VF. Hb and hematocrit are also shown to have statistically significant correlations with BMI, %BF, WC, WHR, and VF. Our study results also prove even in the younger female population the associations for screening for Hb and RCBG may give a clue for identifying people with increased diabetes risk who should go for definitive testing or monitor their blood glucose levels regularly.

### Limitations

This study is cross-sectional which limits its causal inference. Also, we have included only healthy females, and those who have been identified as diabetic had no previous known history. A control group with a known history of diabetes could have given a better comparison.

## Conclusion

In the present study, Haemoglobin and hematocrit were identified as useful tools in predicting risk for diabetes even in the young Saudi female population. Diabetes and anemia relationship could be casual. However, future studies with larger sample sizes are required to obtain more conclusive results.

## Acknowledgements

None.

## Conflict of interest

The study declares no conflict of interest.

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