

Effectiveness of Waist Circumference in Assessing the Health Risk by Evaluating the Cardio Metabolic Risk Factors

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ABSTRACT

BACKGROUND

Obesity is an important risk factor for cardio metabolic diseases like Diabetes, Hypertension, Dyslipidaemia and Coronary Heart Disease (CHD). Several organizations like WHO, National Institutes of Health tried to classify Obesity on basis of weight using BMI. Several epidemiological studies revealed direct correlation between BMI and the risk of medical complications and mortality rate. Body fat distribution is also an important risk factor for obesity-related diseases. Excess abdominal fat also known as central or upper body fat is associated with increased risk of cardio metabolic disease. Janssen et al reported that increased visceral fat, as measured by MRI correlated well with Waist circumference (WC) than with body mass index (BMI). Zhu et al using the third National Health and Nutrition Examination Survey data reported that WC is more closely linked to cardiovascular disease risk factors than BMI. We aimed to determine the effectiveness of waist circumference (WC) in assessment of Health Risk by evaluating the cardio metabolic risk factors.

METHODS

The sample included 238 middle aged factory employees attending the hospital for periodical check-up. This is a cross-sectional hospital-based study. Blood samples are collected in fasting for Triglycerides, LDL, HDL and HbA1c estimation, BP and waist circumference measured. Chi-square is applied to test the goodness of fit to verify the distribution of observed data with assumed theoretical and expected frequencies. Null hypotheses tested with Chi-square.

RESULTS

47.8% subjects of >100 cms waist circumference group documented >400 mg% Triglyceride levels against 21.8% subjects in ≤90 cms waist circumference group. 50% subjects of >100 cms waist circumference group documented >130 mg% LDL levels against 21.8% subjects in ≤90 cms waist circumference group. 45.7% subjects of >100 cms waist circumference group documented <40 mg% HDL levels against 19.1% subjects in ≤90 cms waist circumference group. 43.5% subjects of >100 cms waist circumference group documented >6.5% HbA1c levels against 9.1% subjects in ≤90 cms waist circumference group. Only 10% subjects had normal BP in the group of >100 cms waist circumference against 80% subjects in the low Waist Circumference group (<90 cms). Waist Circumference is well correlated with Triglycerides, LDL, HbA1c and BP readings but inversely correlated with HDL.

CONCLUSIONS

Increasing levels of Waist circumference correlate with several biomarkers of cardiovascular disease and diabetes.

KEY WORDS

Waist Circumference, Triglycerides, Low Density Lipoproteins, High Density Lipoproteins, Glycosylated haemoglobin (HbA1c)

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BACKGROUND

Obesity is an important risk factor for cardio metabolic diseases like Diabetes, Hypertension, Dyslipidemia and Coronary Heart Disease (CHD). Several organizations like WHO, National Institutes of Health tried to classify Obesity on basis of weight using BMI.^{1,2} Several epidemiological studies revealed direct correlation between BMI and the risk of medical complications and mortality rate.^{3,4} Body fat distribution is also an important risk factor for obesity-related diseases. Excess abdominal fat also known as central or upper body fat is associated with increased risk of cardio metabolic disease. Janssen et al⁵ reported that increased visceral fat, as measured by MRI correlated well with Waist circumference (WC) than with body mass index (BMI). Zhu et al⁶ using the third National Health and Nutrition Examination Survey data reported that WC is more closely linked to cardiovascular disease risk factors than BMI. MRI can measure precisely the abdominal fat, but it is costlier. Hence Waist circumference is often used as a surrogate marker of abdominal fat mass as WC correlates with abdominal fat mass.⁷ Waist Circumference is associated well with cardio metabolic disease.⁸ The results presented by Kahn and Valdez reported that WC measurement correlated with elevated fasting triglyceride concentrations and accelerated mortality and served to validate the potential usefulness of WC in physical examination for clinical purposes.⁹ In developing countries like India, to address the consequences of epidemic of Diabetes and cardio vascular problems, WC measurement would offer useful, inexpensive tool for early screening and intervention. Jack Wang stressed Waist circumference, a simple, inexpensive and reliable tool that should be included as part of physical examinations in the doctor's office.¹⁰ Measuring WC can be useful in monitoring a patient's response to diet and exercise treatment because regular aerobic exercise can cause a reduction in both WC and cardio metabolic risk, without a change in BMI.¹¹ Samuel Klein et al opined that further studies are needed to establish WC cut points that can assess cardio metabolic risk, not adequately captured by BMI and routine clinical assessments.¹² Hence the present study aimed to evaluate the effectiveness of WC in assessing the Health risk by evaluating the cardio metabolic risk factors and also to validate the results of the previous studies.

METHODS

The sample included 238 middle aged, male factory employees randomly selected from 626 employees of a factory. Sample calculated by formula and as uploaded in Survey Software with 95% confidence level. Blood samples are collected in fasting for Triglycerides, LDL, HDL and HbA_{1c} estimation, BP measurement and Waist measurement.

Duration and Place of the Study

238 middle aged, male factory employees randomly selected from a factory and consent was taken for the present study to utilize the data for analysis and presentation. The study spread for 10 months from the month of July, 2018 to the month of April, 2019. Ethical committee approval obtained. The variable Waist Circumference is taken as independent variable and

Triglycerides, LDL, HDL, HbA_{1c}, BP are measured as independent variables. The confounding variables age, sex are under control by including male, middle aged, healthy subjects in the study. Female subjects and refusal to give informed consent are excluded.

Waist Circumference

Waist measurement taken midway between iliac crest and the lower edge of the rib cage. Basing on Waist Measurement, all the 238 subjects are categorized into 3 groups. 110 subjects in ≤ 90 cms, 82 subjects in 91 cms – 100 cms, 46 subjects in >100 cms.

Triglyceride Levels

All subjects are categorized into 3 groups, ≤ 150 mg%, 151-399 mg%, ≥ 400 mg%

LDL Levels

All subjects are categorized into 3 groups, ≤ 100 mg%, 101-129 mg%, ≥ 130 mg%

HDL Levels

All subjects are categorized into 3 groups, ≤ 40 mg%, 41- 60 mg%, >60 mg%

HbA_{1c} Levels

All subjects are categorized into 3 groups, $<5.7\%$, $\geq 5.7-6.5\%$, $\geq 6.5\%$.

BP Levels

BP measured and all subjects are categorized into 4 groups, Normal: Systolic ≤ 120 mm Hg and Diastolic ≤ 80 mm Hg. Pre-Hypertension: Systolic 120-129 mm Hg and Diastolic ≤ 80 mm Hg. Stage 1 Hypertension: Systolic 130-139 mm Hg and Diastolic 80-89 mm Hg. Stage 2 Hypertension: Systolic ≥ 140 mm Hg and Diastolic ≥ 90 mm Hg.

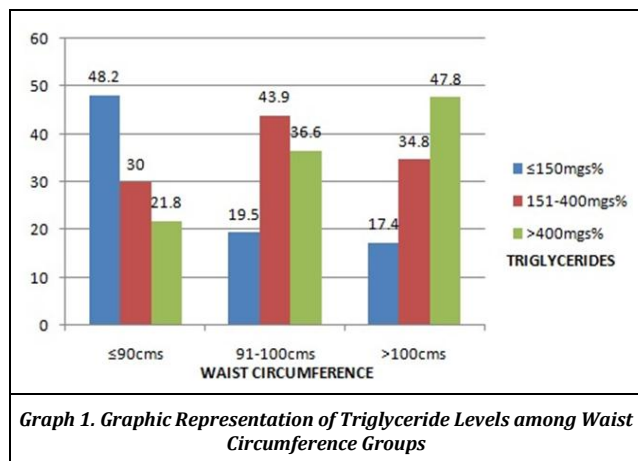
Statistical Techniques

Chi-square is applied to test the goodness of fit to verify the distribution of observed data with assumed theoretical and expected frequencies. A null hypothesis is established. The difference between observed value and expected value calculated. $(O-E)$. Square of the deviation calculated $(O-E)^2$. $(O-E)^2$ is divided by its expected frequency. $(O-E)^2/E$. All the values obtained in step 4 are summed. $\Sigma [(O-E)^2/E]$. Degrees of freedom is calculated by formula $(C-1) (R-1)$. The table value of X^2 found at the level of significance 0.05 and degrees of freedom. The table value is compared to the calculated value. If calculated value is more than the table value, the null hypothesis is rejected. If calculated value is less than the table value, the null hypothesis is retained.

RESULTS

Regarding Triglycerides concentrations, 238 subjects are distributed as follows. 53 (48.2%) in ≤ 150 mg%, 33 (30%) in 151-400 mg%, 24 (21.8%) in >400 mg% in ≤ 90 cms Waist circumference group, 16 (19.5%) in ≤ 150 mg%, 36 (43.9%) in 151-400 mg%, 30 (36.6%) in >400 mg% in the 91-100 cms Waist Circumference group, 8 (17.4%) in ≤ 150 mg%, 16

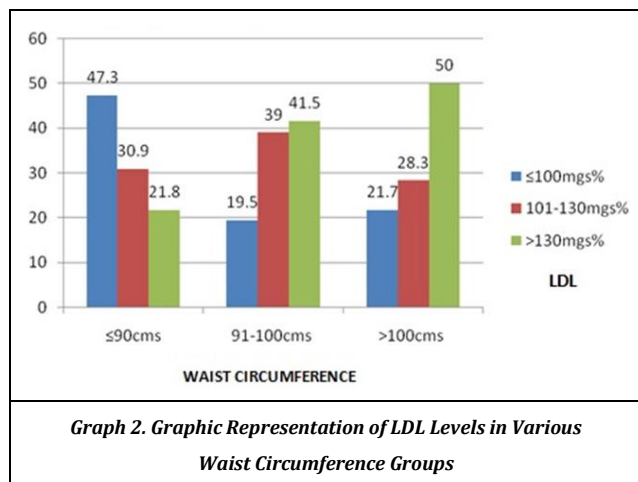
(34.8%) in 151-400 mg%, 22 (47.8%) in >400 mg% in the group >100 cms Waist circumference group. The percentile distribution of high Triglycerides is more in the group >100 cms Waist Circumference.



Graph 1. Graphic Representation of Triglyceride Levels among Waist Circumference Groups

At Degrees of freedom, 4 and at significance of 0.05, Chi-Square Table value is 9.488. The calculated value is 26.16 which is more than Table value. So null hypothesis that there is no difference in Triglyceride levels among the various groups of Waist Circumference is rejected. Hence there is significant raise in the TG levels in the subjects with more waist circumference.

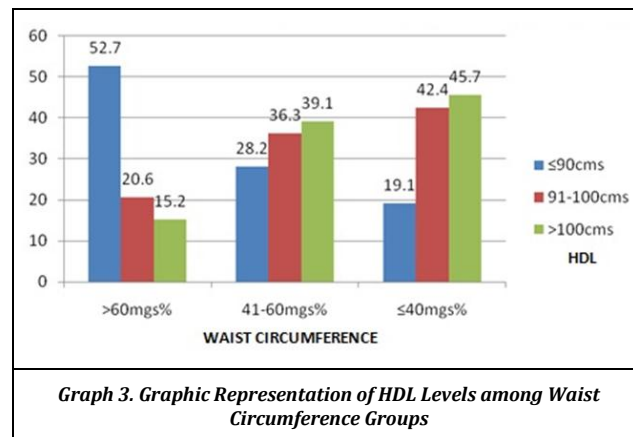
Regarding LDL concentrations, 238 subjects are distributed as follows. 52 (47.3%) in ≤100 mg%, 34 (30.9%) in 101-130 mg%, 24 (21.8%) in >130 mg% in ≤ 90 cms Waist circumference group, 16 (19.5%) in ≤100 mg%, 32 (39%) in 101-130 mg%, 34 (41.5%) in >130 mg% in the group 91-100 cms Waist Circumference group, 10 (21.7%) in ≤100 mg%, 13 (28.3%) in 101-130 mg%, 23 (50%) in >130 mg% in the group >100 cms Waist circumference group. The percentile distribution of high LDL is more in the group >100 cms Waist Circumference.



Graph 2. Graphic Representation of LDL Levels in Various Waist Circumference Groups

At Degrees of freedom, 4 and at significance of 0.05, Chi-Square Table value is 9.488. The calculated value is 24.11 which is more than table value. So, the null hypothesis that there is no difference in LDL levels among the various groups of Waist circumference is rejected. Hence there is significant raise in the LDL levels in the subjects with more waist circumference.

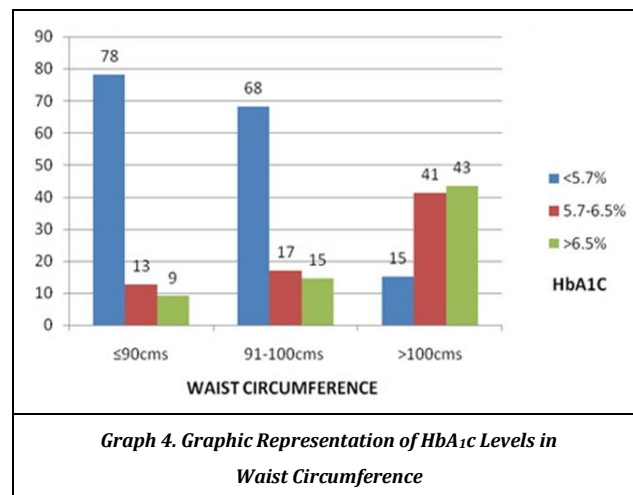
Regarding HDL concentrations, 238 subjects are distributed as follows. 58 (52.7%) in >60 mg%, 31 (28.2%) in 41-60%, 21(19.1%) in ≤40 mg% in ≤ 90 cms Waist circumference group, 17 (20.6%) >60 mg%, 30 (36.3%) in 41-60 mg%, 35 (42.4%) in ≤40 mg% in the group 91-100 cms Waist Circumference group, 7 (15.2%) in >60 mg%, 18 (39.1%) in 41-60 mg%, 21 (45.7%) in ≤40 mg% in the group >100 cms Waist circumference group. The percentile distribution of low HDL is more in the group >100 cms Waist Circumference.



Graph 3. Graphic Representation of HDL Levels among Waist Circumference Groups

At Degrees of freedom, 4 and at significance of 0.05, Chi-Square Table value is 9.488. The calculated value is 32.89 which is more than table value. Hence the null hypothesis, that there is no difference in HDL levels among the various groups of Waist circumference is rejected. Hence there is significant raise in the HDL levels in the subjects with less waist circumference.

Regarding HbA1c levels, 238 subjects are distributed as follows. 86 (78.2%) in <5.7%, 14 (12.7%) in 5.7-6.5%, 10 (9.1%) in >6.5% in ≤ 90 cms Waist circumference group, 56 (68.3%) in <5.7%, 14 (17.1%) in 5.7-6.5%, 12 (14.6%) in >6.5% in 91-100 cms Waist Circumference group, 7 (15.2%) in <5.7%, 19 (41.3%) in 5.7-6.5%, 20 (43.5%) in >6.5% in the group >100 cms Waist circumference group. The percentile distribution of high HbA1c levels more in the group >100 cms Waist Circumference.

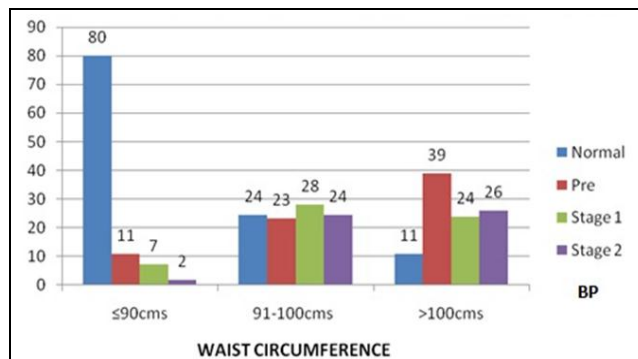


Graph 4. Graphic Representation of HbA1c Levels in Various Waist Circumference

At Degrees of freedom, 4 and at significance of 0.05, Chi-Square Table value is 9.488. The calculated value is 57.43 which is more than table value. Hence the null hypothesis that

there is no difference in HbA1c levels among the various groups of waist circumference is rejected. Hence there is significant rise in the HbA1c levels in the subjects with more waist circumference.

Regarding BP levels, 238 subjects are distributed as follows. 88 (80%) in Normal, 12 (10.9%) in Pre Hypertension, 8 (7.3%) in Stage 1 Hypertension, 2 (1.8%) in Stage 2 Hypertension in ≤ 90 cms Waist circumference group, 20 (24.4%) in Normal, 19 (23.2%) in Pre, 23 (28%) in Stage 1, 20 (24.4%) in Stage 2 in 91-100 cms Waist Circumference group, 5 (10.9%) in Normal, 18 (39.1%) in Pre, 11(23.9%) in Stage 1, 12 (26.1%) in Stage 2 in the group >100 cms Waist circumference group. The percentile distribution of Normal BP is more in the group ≤ 90 cms Waist Circumference.



Graph 5. Graphic Representation of BP Levels among Waist Circumference Groups

At degrees of freedom 6 and at the significance level of 0.05, the Table value is 12.592. The calculated value is 94.72 which is more than the table value, hence the null hypothesis that there is no difference in Blood Pressure levels among the various groups is rejected. There is significant rise in the Blood pressure levels in the subjects with more waist circumference. The percentage of normal BP is more in Low Waist circumference groups.

DISCUSSION

Triglycerides and Waist Circumference

The Null hypothesis that there is no difference in Triglyceride levels among the various groups of Waist Circumference is tested with Chi-square. With Df 4 and at 0.05 significant levels, Chi-Square table value is 9.488. The calculated value is 26.16 which is more than Table value. So null hypothesis that there is no difference in Triglyceride levels among the various groups of Waist Circumference is rejected. 47.8% subjects of more than 100 cms waist circumference documented more than 400 mg% Triglyceride levels whereas only 21.8% had more than 400 mg% Tg levels in ≤ 90 cms waist circumference group. Hence the study revealed that there is significant raise in the TG levels in the subjects with more waist circumference.

Low Density Lipoproteins and Waist Circumference

The Null hypothesis that there is no difference in Low Density Lipoproteins levels among the various groups of Waist Circumference is tested with Chi-square. With Df 4 and at 0.05 significant levels, Chi-Square table value is 9.488. The

calculated value is 24.11 which is more than Table value. So null hypothesis that there is no difference in Low Density Lipoproteins levels among the various groups of Waist Circumference is rejected. 50% subjects of more than 100 cms waist circumference documented more than 130 mg% LDL levels whereas only 21.8% had more than 130 mg% LDL levels in ≤ 90 cms waist circumference group. The study revealed that there is significant raise in the LDL levels in the subjects with more waist circumference.

High Density Lipoproteins and Waist Circumference

The Null hypothesis that there is no difference in High Density Lipoproteins levels among various groups of Waist Circumference is tested with Chi-square. With Df 4 and at 0.05 significant levels, Chi-Square table value is 9.488. The calculated value is 32.89 which is more than Table value. So null hypothesis that there is no difference in High Density Lipoproteins levels among the various groups of Waist Circumference is rejected. 45.7% subjects of more than 100 cms waist circumference documented less than 40 mg% HDL levels whereas only 19.1% only documented less than 40 mg% HDL levels in ≤ 90 cms waist circumference group. The study revealed that there is significant diminution in the HDL levels in the subjects with more waist circumference.

HbA1c Levels and Waist Circumference

The Null hypothesis that there is no difference in Glycosylated Haemoglobin (HbA1c) levels among various groups of Waist Circumference is tested with Chi-square. With Df 4 and at 0.05 significant levels, Chi-Square table value is 9.488. The calculated value is 57.43 which is more than Table value. So null hypothesis that there is no difference in HbA1c levels among the various groups of Waist Circumference is rejected. 43.5% subjects of more than 100 cms waist circumference documented more than 6.5% HbA1c levels whereas only 9.1% subjects documented more than 6.5% HbA1c levels in ≤ 90 cms waist circumference group. The study revealed that there is significant increase in the HbA1c levels in the subjects with more waist circumference.

Blood Pressure Levels and Waist Circumference

The Null hypothesis that there is no difference in Blood Pressure levels among various groups of Waist Circumference is tested with Chi-square. With Df 6 and at 0.05 significant levels, Chi-Square table value is 12.592. The calculated value is 94.72 which is more than Table value. So null hypothesis that there is no difference in BP levels among the various groups of Waist Circumference is rejected. The study revealed that there is significant increase in the Blood Pressure levels in the subjects with more waist circumference. Only 10% subjects had normal BP in the group of more than 100 cms waist circumference whereas 80% of cases of normal BP (80%) found in the low Waist Circumference group (< 90 cms).

CONCLUSIONS

Waist Circumference is well correlated with Triglycerides, LDL, HbA1c and BP readings but inversely correlated with HDL. The high levels of Waist Circumference correlated well with several biomarkers of Cardiovascular Disease and Diabetes. The present study correlated well with the previous

studies of waist circumference and cardio metabolic risk factors. The present study emphasizes the importance of Waist circumference which is cheap, simple and reliable tool not only for screening but also for monitoring to assess the diet and exercise regimen. Every doctor should include the Waist Circumference as part of physical examination to address the epidemic of Obesity and Diabetes.

REFERENCES

- [1] World Health Organization. Obesity: preventing and managing the global epidemic: Report of a WHO Consultation on Obesity. Geneva, World Health Organization, 1998: p. 7-9.
- [2] National Institutes of Health. National Heart, Lung and Blood Institute: Clinical guidelines on the identification, evaluation and treatment of overweight and obesity in adults - the evidence report. *Obes Res* 1998;6(Suppl 2):51S-209S.
- [3] Colditz GA, Willett WC, Rotnizky A, et al. Weight gain as a risk factor for clinical diabetes mellitus in women. *Ann Intern Med* 1995;122(7):481-6.
- [4] Calle EE, Thun MJ, Petrellin JM, et al. Body-mass index and mortality in a prospective cohort of U.S. adults. *N Engl J Med* 1999;341(15):1097-105.
- [5] Janssen I, Heymsfield SB, Allison DB, et al. Body mass index and waist circumference independently contribute to the prediction of non-abdominal, abdominal subcutaneous and visceral fat. *Am J Clin Nutr* 2002;75(4):683-8.
- [6] Zhu S, Wang Z, Heshka S, et al. Waist circumference and obesity-associated risk factors among whites in the third National Health and Nutrition Examination Survey: clinical action thresholds. *Am J Clin Nutr* 2002;76(4):743-9.
- [7] Pouliot MC, Despres JP, Lemieux S, et al. Waist circumference and abdominal sagittal diameter: best simple anthropometric indices of abdominal visceral adipose tissue accumulation and related cardiovascular risk in men and women. *Am J Cardiol* 1994;73(7):460-8.
- [8] Kissebah AH, Vydelingum N, Murry R, et al. Relation of body fat distribution to metabolic complications of obesity. *J Clin Endocrinol Metab* 1982;54(2):254-60.
- [9] Kahn HS, Valdez R. Metabolic risks identified by the combination of enlarged waist and elevated triacylglycerol concentration. *Am J Clin Nutr* 2003;78(5):928-34.
- [10] Wang J. Waist circumference: a simple, inexpensive and reliable tool that should be included as part of physical examinations in the doctor's office. *Am J Clin Nutr* 2003;78(5):902-3.
- [11] Dekker MJ, Lee S, Hudson R, et al. An exercise intervention without weight loss decreases circulating interleukin-6 in lean and obese men with and without type 2 diabetes mellitus. *Metabolism* 2007;56(3):332-8.
- [12] Klein S, Allison DB, Heymsfield SB, et al. Waist circumference and cardiometabolic risk: a consensus statement from shaping America's health: Association for Weight Management and Obesity Prevention, NAASO, the Obesity Society, the American Society for Nutrition, and the American Diabetes Association. *Diabetes Care* 2007;30(6):1647-52.