Original Article

JCMCTA 2024 ; 35 (1) : 77-81

Association of Anthropometric Indices with Insulin Resistance in Nonalcoholic Fatty Liver Disease

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Abstract

Background: The prevalence of obesity and Metabolic Syndrome (MS) has increased globally, leading to Non Alcoholic Fatty Liver Disease (NAFLD) becoming the most prevalent liver disorder worldwide. Various studies have indicated that Waist Circumference (WC) serves as a surrogate marker for visceral fat accumulation, while waist-hip ratio is suggested as a superior screening tool for NAFLD compared to Body Mass Index (BMI). The objective of this study was to assess the correlation between anthropometric indices and Insulin Resistance (IR) in NAFLD patients at Chittagong Medical College Hospital (CMCH).

Materials and methods: This cross-sectional study was conducted at the Department of Biochemistry, Institute of Nuclear Medicine and Allied Sciences (INMAS) in collaboration with Chittagong Medical College Hospital (CMCH). One hundred and fifty (150) subjects aged between 18-60 years were enrolled using a non-probability consecutive sampling method. NAFLD subjects were identified through ultrasonography and detailed anthropometric measurements were recorded. IR was evaluated using the Homeostatic Model Assessment of Insulin Resistance (HOMA-IR).

Results: Among the NAFLD subjects, 81.3% were classified as obese. The BMI of NAFLD subjects was significantly higher compared to non-NAFLD subjects (26.60±0.29 vs. 21.15 ± 0.25 kg/m2). Furthermore, 90% of NAFLD subjects exhibited central obesity, as indicated by WC. Regardless of gender, NAFLD subjects demonstrated significantly higher WC and waist-hip ratios. IR (HOMA-IR > 2.6) was more prevalent among obese NAFLD subjects (94% vs. 77%).

Conclusions: BMI, WC, and Waist-Hip Ratio are associated with IR in NAFLD patients, suggesting their utility in predicting NAFLD.

Key words: Body Mass Index (BMI); Homeostatic Model Assessment of Insulin Resistance (HOMA-IR); Insulin Resistance (IR); Metabolic Syndrome (MS); Nonalcoholic Fatty Liver Disease (NAFLD); Waist Circumference (WC).

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Submitted on : 23.04.2024
Accepted on : 20.05.2024

Introduction

First coined by Ludwig et al. at Mayo Clinic in 1980, the term Non-Alcoholic Steatohepatitis (NASH) has spurred significant research over the past two decades, leading to NAFLD's recognition as a global health concern.[1,2] Anthropometric measurements such as BMI and WC have been linked to hyper insulinemia and NAFLD severity.[3,4] NAFLD, characterized by hepatic lipid accumulation, resembles alcoholic liver disease but occurs in individuals without chronic alcohol consumption history.[5] NAFLD spans a spectrum from steatosis to cirrhosis and end-stage liver disease, often complicating diagnoses of cryptogenic cirrhosis and hepatocellular carcinoma.[6,7] Frequently associated with obesity, IR, diabetes, hyperlipidemia, and MS, NAFLD's prevalence in obese adults ranges from 39 to 95%.[8]

Central obesity, rather than overall obesity, appears pivotal in NAFLD pathogenesis, with IR playing a central role.[9] IR is characterized by either elevated insulin concentrations or insufficient metabolic responses to normal insulin levels. Marchesini et al. demonstrated IR's strong association with NAFLD, regardless of BMI, fat distribution, or glucose intolerance, using the HOMA-IR method.[10]

Visceral fat is crucial in MS and NAFLD pathogenesis, being an endocrine organ secreting hormones, peptides and adipokines regulating metabolism and inflammation.[11] Proinflammatory adipokines from visceral fat contribute to metabolic risk factors associated with NAFLD, including hypertension, dyslipidemia, and IR.[12,13,14] NAFLD identification through simple anthropometric markers such as WC and waist-to-hip ratio underscores the importance of abdominal obesity assessment.[15] Limited therapeutic options for NAFLD highlight the significance of weight loss and lifestyle modifications, emphasizing the need for appropriate anthropometric obesity marker cutoffs to predict NAFLD.[15]

Thus, BMI, waist-hip ratio and WC serve as crucial parameters in evaluating obesity grade. This study aims to assess the significance of these anthropometric measurements in NAFLD patients and their association with IR.

Materials and methods

This study was aimed to investigate Non-Alcoholic Fatty Liver Disease (NAFLD) in a sample of 150 subjects aged 18-60 years over a one-year period from June 2017 to June 2018. Conducted at the Department of Biochemistry, INMAS and CMCH, subjects of both sexes underwent sonographic evaluation and were categorized into NAFLD cases (n=80) and non-NAFLD controls (n=70). Exclusion criteria included positive tests for hepatitis B virus surface antigen or anti-hepatitis C virus antibody, liver cirrhosis, acute or chronic hepatitis, alcohol abuse history, type II Diabetes Mellitus (DM) and pregnancy.

Data collection utilized a pre-tested structured questionnaire with all relevant variables after obtaining informed written consent. Standard phlebotomy procedures were employed to draw 5 ml of fasting venous blood from the median cubital vein between 8 and 9 am, which was then placed into clean, dry test tubes. Following centrifugation, serum was separated and transferred to Eppendorf tubes, promptly transported to the Biochemistry Laboratory for analysis.

Insulin Resistance (IR) was calculated using the Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) formula: HOMA-IR = [(Fasting plasma glucose in mmol/L) × (Fasting serum insulin in μIu/L)] ÷ 22.5. Standing height and weight were measured using a stadiometer, with height recorded to the nearest 5 mm and weight to the nearest 0.5 kg. Body Mass Index (BMI) was calculated using the formula: BMI = Weight (kg) / Height (m^2). Waist Circumference (WC) was measured to the nearest 0.5 cm using a soft, non-elastic measuring tape, taken between the lower border of the 12th rib and the highest point of the iliac crest on the mid-axillary line at the end of normal expiration. Before commence the study ethical approval was taken from the authorities.

Results

Statistical analysis was performed by using SPSS V.20.0. Data was expressed as mean ± SEM. Confidence level was fixed at 95% level and p-value of 0.05 or less was considered significant. Student t-test for quantitative or continuous variable, Chi-square test for qualitative or categorical variables was used to measure the significance.Tables were drawn in respective presentation when applicable. The findings obtained from data analysis are presented below:

BMI was significantly higher in NAFLD subjects (26.60±0.29 vs. 21.15 ± 0.25kg/m^2). 81.3% of the patients of NAFLD were obese [Table: I]. 90% of the NAFLD subjects had central obesity. Irrespective of the gender the NAFLD group had significantly higher WC and Waist hip ratio than non NAFLD control group [Table II & III].

IR was more prevalent among the NAFLD subjects. 90% NAFLD caseshad insulin resistance with HOMA-IR >2.6. IRwas also more prevalent among obese NAFLD subjects (94% versus 77%). This difference was statistically significant with Odds ratio 4.53, 95% CI (1.32-9.82) and p value 0.03. Thus Obese NAFLD cases were 4.53 times more likely to have insulin resistance [Table IV]. IR was also prevalent among cases with increased waist to hip ratio than the normal NAFLD cases (92% versus 60%) [Table V].

Table I Distribution of the study subjects according to their BMI

BMI, in Kg/m^2	Case (n=80)		Control (n=70)		Test statistics
Category	n	%	n	%	p value
Normal (<23)	3	3.8	60	85.7	
Overweight (23-24.99)	12	15.0	7	10.0	χ^2 =109.24 p<0 .001
Obese (≥25)	65	81.3	3	4.3	
Mean ± SEM	26.60 ± 0.29		21.15 ± 0.25		p<0.001

Table II Distribution of the study subjects according to their waist circumference

Waist circumference (cm)	Case (n=80)		Control (n=70)		Test statistics
Category	n	%	n	%	p value
Normal	8	10.0	70	100.0	p< 0.001
Central obesity	72	90.0	0	0.0	
Gender	Mean ±SEM		Mean ±SEM		p value
Male	95.83±1.59		72.59±0.69		p<0 .001
Female	96.11±1.03		66.37 ±0.41		p< 0.001

Table III Comparison of waist hip ratio amongst the study population (n=150)

Waist hip ratio	Cases (n=80) (Mean ± SEM) (Range)	Controls (n=70) (Mean ± SEM) (Range)	p value
Male	0.96 ± 0.016 (0.79 - 1.2)	0.80 ± 0.006 (0.72 – 0.85)	p < 0.00001
Female	0.94 ± 0.004 (0.89 - 0.99)	0.76 ± 0.004 (0.67 - 0.82)	p < 0.00001

Table IV Association between NAFLD and insulin resistance status (HOMA-IR) amongst the study population (n=150)

Groups	Category of HOMA-IR		Total	Odds ratio (95% confidence interval)	p value & test statistic
	HOMA-IR >2.6	HOMA-IR ≤2.6			
NAFLD (Cases)	72 (90%)	08 (10%)	80	15.23 (6.34-36.59)	χ^2 = 46.05 p < 0.001
Non-NAFLD (Controls)	26 (37%)	44 (63%)	70		
Total	98 (65%)	52 (35%)	150		

Table V Association between obesity and insulin resistance (HOMA-IR) in cases (n = 80)

BMI category (Kg/m^2)	Category of HOMA-IR		Total	Odds ratio (95% CI)	p value (Significance)
	HOMA-IR >2.6	HOMA-IR ≤2.6			
Non-obese (BMI<25)	13 (77%)	04 (23%)	17 (100%)	4.53 (1.32-9.82)	χ^2= 4.39 p=0.03
Obese (BMI ≥ 25)	59 (94%)	04 (06%)	63 (100%)		
Total	72 (90%)	08 (10%)	80 (100%)		

Table VI Association between waist hip ratio and insulin resistance (HOMA-IR) in cases (n= 80)

Waist hip ratio	Category of HOMA-IR		Total	Odds ratio	p value (Significance)
	HOMA-IR >2.6	HOMA-IR ≤2.6			
Normal	03 (60%)	02 (40%)	05 (100%)	7.67 (2.03-10.45)	χ^2= 5.33 p = 0.02
Increased	69 (92%)	06 (08%)	75 (100%)		
Total	72 (90%)	08 (10%)	80 (100%)		

Discussion

Non Alcoholic Fatty Liver Disease (NAFLD) encompasses a spectrum of conditions characterized by hepatic lipid accumulation, ranging from Non Alcoholic Steatohepatitis (NASH) to advanced fibrosis and cirrhosis. It is strongly associated with obesity and Insulin Resistance (IR) and is considered the hepatic component of Metabolic Syndrome (MS).[16,17] The present study confirmed a higher prevalence of IR among subjects with NAFLD, as evidenced by significantly elevated BMI, central obesity (90% of NAFLD subjects) and higher waist circumference (WC) and waist-hip ratio compared to non-NAFLD controls. This finding aligns with previous research by E. Bugianesi et al. Yoosoo et al. Kelley DE et al. and Rushad Patel et al. demonstrating similar associations between obesity, IR, and NAFLD.[9,18-20] However, some authors have failed to establish such associations, indicating the complexity of the relationship between IR components and NAFLD.[21,22]

Visceral fat deposition plays a central role in the pathogenesis of both MS and NAFLD, contributing to abnormal adipokine production and pro-inflammatory signaling pathways activation. Abdominal obesity, characterized by high levels of pro-inflammatory markers and low adiponectin levels, is implicated in the development of IR and steatohepatitis.[23] Several studies have demonstrated the predictive value of abdominal obesity indices, including WC and waist-hip ratio, for diagnosing MS.[24] While these indices are incorporated into ATP III diagnostic criteria for MS, their utility in diagnosing NAFLD remains underexplored[25]. However, this study and others have shown that simple anthropometric indices such as WC, BMI, and waist-hip ratio are elevated in NAFLD subjects, suggesting their potential as diagnostic tools. Studies by Yooet al. and Zheng et al. have further supported the utility of these indices for predicting NAFLD in Korean and Chinese populations, respectively.[26,27]

Fatty liver disease poses significant health risks, progressing to steatohepatitis, fibrosis, cirrhosis and hepatocellular carcinoma.[28] Additionally, its association with MS and adverse cardiovascular events underscores the importance of identifying anthropometric predictors for early detection and management.[29] While WC is a well-established surrogate marker for abdominal fat accumulation and cardio-metabolic disease risk, waist-hip ratio has emerged as a better indicator of centripetal obesity and a significant risk factor for MS and increased cardiovascular mortality.[30] However, the establishment of cutoff values for these indices in the context of NAFLD, especially among Asian populations, remains limited despite differences in metabolic and abdominal obesity profiles compared to Western populations.[31,32]

In conclusion, this study emphasizes the importance of anthropometric indices, particularly WC, waist-hip ratio, and BMI, in identifying NAFLD and predicting associated metabolic risks. Further research is warranted to establish standardized cutoff values for these indices in diagnosing NAFLD, particularly in Asian populations, to facilitate early detection and intervention.

Limitations

The study has certain limitations which includes short duration of time, small sample size, cross sectional study and not assessing NAFLD by Liver biopsy

Conclusion

The study revealed that there was positive association of Anthropometric indices with Insulin Resistance amongst the NAFLD study population.

Recommendations

Further prospective multicenter study in large scale is necessary to better understand the strategy of anthropometric indicesand its relation with IR in NAFLD.

Acknowledgement

Author express his gratitude to the staffs of the Department of Biochemistry of INMAS & CMCH.

Contribution of author

Whole study was conducted by the author himself.

Disclosure

All the authors declared no competing interest.

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