Section: Anatomy

Original Research Article

ULTRASONOGRAPHIC CORRELATION BETWEEN PANCREATIC DIMENSIONS AND BODY MASS INDEX (BMI)

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ABSTRACT

Background: Rising global obesity has increased interest in its effects on pancreatic structure, particularly as higher Body Mass Index (BMI) contributes to metabolic conditions such as Type 2 Diabetes Mellitus and non-alcoholic fatty pancreas disease (NAFPD). However, clear quantitative data linking BMI with pancreatic dimensions remain limited. The aim is to assess the correlation between BMI and ultrasonographic anterior–posterior (AP) dimensions of the pancreatic head, body, and tail.

Materials and Methods: This retrospective study evaluated 300 healthy adults (>31 years). Ultrasound data were collected from JLN Medical College, Ajmer, and analyzed at GMC Banswara. Pancreatic measurements were obtained using a SAMSUNG HS70A system with a 2.5–5 MHz probe. Data were analyzed using SPSS version 27.

Results: Pancreatic dimensions increased progressively with BMI. The head enlarged from 1.93 cm (underweight) to 2.25 cm (overweight/obese), though this change was not statistically significant. The body showed a significant increase from 1.34 cm to 1.48 cm ($P = 0.023$). The tail demonstrated the most marked change, increasing from 1.21 cm to 2.46 cm, with high statistical significance ($P < 0.001$). Overall, pancreatic size showed a positive correlation with BMI.

Conclusion: BMI is significantly associated with increased pancreatic size, particularly in the body and tail segments. These findings provide useful sonographic reference values and highlight the pancreas—especially the tail—as a sensitive indicator of obesity-related morphological change.

Keywords: Ultrasonography, Correlation, Pancreas, Body Mass Index (BMI).

INTRODUCTION

The global surge in overweight and obesity has emerged as one of the most pressing public health concerns of the 21st century. Body Mass Index (BMI), a simple yet widely accepted anthropometric index, serves as the primary tool for quantifying adiposity and stratifying individuals according to weight-related health risks.[1] Its growing numerical trend mirrors a parallel rise in metabolic disorders, most notably Type 2 Diabetes Mellitus (T2DM), metabolic syndrome, cardiovascular disease, and increasingly recognized conditions such as non-alcoholic fatty pancreas disease (NAFPD). Among these, pancreatic involvement is of particular interest because the pancreas plays a central role in both digestive function and glucose homeostasis. As systemic adiposity increases, metabolic changes exert direct and indirect impacts on pancreatic morphology and function, often manifesting as impaired beta-cell activity, altered echogenicity, and ectopic fat accumulation within the pancreatic parenchyma.[2]

Although pancreatic steatosis and its clinical relevance have been extensively documented in literature, the relationship between increased BMI and structural changes of the pancreas remains insufficiently quantified. While functional

impairments are well recognized, there is still limited consensus regarding how pancreatic size—particularly its anterior-posterior (AP) dimensions—varies across different BMI categories.[3] Establishing this correlation is crucial because deviations from normal biometry may serve as early markers of pathological processes.[4,5] For instance, glandular enlargement may indicate inflammatory changes such as acute pancreatitis, whereas reduced dimensions may reflect chronic atrophic changes commonly observed in long-standing diabetes. Therefore, defining normative pancreatic measurements across BMI strata becomes foundational for improving diagnostic accuracy in routine imaging practice.[6-8]

Ultrasonography (US) has long been accepted as the first-line, non-invasive modality for evaluating abdominal organs, including the pancreas. It offers numerous advantages—lack of ionizing radiation, affordability, ease of availability, and the ability to obtain real-time dynamic images. Despite limitations such as reduced visualization in individuals with central obesity, US remains a reliable tool for assessing pancreatic dimensions when performed under optimal conditions by experienced operators. Its capability to precisely measure the head, body, and tail makes it indispensable for morphometric studies.[9,10]

Given the rising incidence of obesity and its impact on pancreatic morphology, there is a compelling need for systematic research that characterizes pancreatic dimensions in relation to BMI. This study aims to bridge this knowledge gap by evaluating the correlation between BMI and the AP diameters of the pancreatic head, body, and tail using high-resolution transabdominal ultrasonography.[3] By generating robust reference ranges, the study intends to enhance the accuracy of sonographic interpretation, support early detection of pathological deviations, and contribute to a deeper understanding of pancreatic adaptation amid the expanding global obesity burden.[7,11]

MATERIALS AND METHODS

This retrospective study was conducted. Ultrasound data were collected from the Department of Radiology, Jawaharlal Nehru Medical College, Ajmer, and later was assessed by the author at Government Medical College, Banswara, Rajasthan.

Sample Size: Sample Size: Minimum 100 n = z2 × p (1 – p)/E2 z = z score = 1.96 p = prevalence = 6% (Rajasthan) E = Margin of error = 5% N = 87 ~ 100 To increase accuracy, 300 subjects were included in study group (healthy adults >31 years).

Study Population: 300 healthy adults

Inclusion Criteria

- Adults >31 years (healthy).
- Adults <70 years (healthy).

Exclusion Criteria

- Age <31 years and >70years, pancreatic/liver disease, systemic/metabolic disorders, anatomical variations, pregnancy, long-term medication, inadequate fasting, recent barium study.

Ethics: Approval was obtained from the Institutional Ethical Committee, JLN Medical College, Ajmer. Written informed consent was taken from all participants.

Ultrasound Examination

A SAMSUNG HS70A ultrasound machine with a 2.5–5 MHz probe was used.

Examination positions included supine, right/left anterior oblique, and upright.

Pancreatic visualization was optimized using high epigastric and transgastric sections and the left liver lobe as an acoustic window.

Statistical Analysis: Data were analyzed using SPSS version 27 and expressed as mean ± SD.

RESULTS

Ultrasonographic measurements show that pancreatic dimensions generally increase as Body Mass Index (BMI) rises across underweight (BMI < 18.5 kg/m2), normal (BMI = 18.5-24.9 kg/m2), overweight (BMI = 25.0-29. kg/m2), and obese (BMI> 30 kg/m2), groups. Specifically, the mean size of the pancreatic head increases from 1.93CM (underweight) to 2.25cm (overweight/obese), though this trend is not statistically significant. The pancreatic body 1.34 cm to 1.48 cm and tail 1.21 cm to 2.46cm also enlarge with increasing BMI. The increasing size trend for the pancreatic body is statistically significant, and for the pancreatic tail, it is highly statistically significant, confirming that overall pancreatic size is positively correlated with BMI.

Table 1: Comparison of Body Mass Index (BMI) With Pancreatic size

Pancreatic Size	BMI (kg/m2)	Number	Mean (cm)	S.D	P value	Significance
Head	<18.5	1	1.93	.	0.114	NS
	18.5– 24.9	131	2.16	0.35		
	25.0– 29.9	100	2.25	0.31		
	≥30	68	2.25	0.37		
	Total	300	2.21	0.34		
Body	<18.5	1	1.34	.	0.023	S
	18.5– 24.9	131	1.38	0.19		
	25.0– 29.9	100	1.48	0.27		
	≥30	68	1.44	0.26		
	Total	300	1.43	0.24		

Tail	<18.5	1	1.21	.	<0.001	HS
	18.5– 24.9	131	2.31	0.27		
	25.0– 29.9	100	2.43	0.33		
	≥30	68	2.46	0.36		
	Total	300	2.38	0.32		

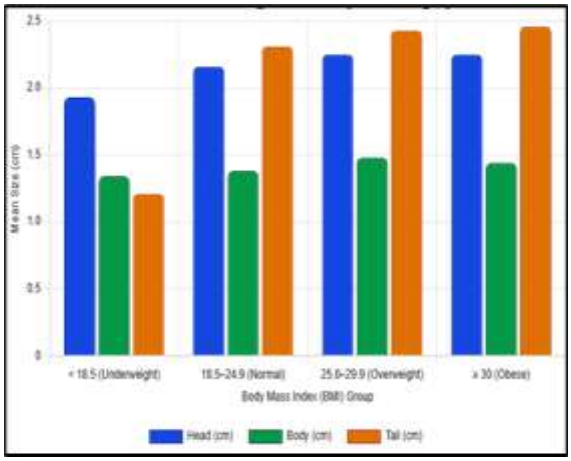

Figure 1: Mean pancreatic segment size by BMI Category

DISCUSSION

The primary objective of this study was to quantitatively assess the correlation between Body Mass Index (BMI) and the ultrasonographic dimensions of the pancreas. The results unequivocally demonstrate a positive and statistically significant relationship between increasing BMI and the size of the pancreatic body ($P = 0.023$) and, most strikingly, the pancreatic tail ($P < 0.001$). This morphological change aligns with mounting evidence of metabolic stress induced by obesity, which commonly leads to non-alcoholic fatty pancreas disease (NAFPD) and glandular enlargement due to ectopic fat infiltration, a finding supported by literature.[3,7,12]

The highly significant enlargement of the pancreatic tail rising from 1.21cm to 2.46 cm in the obese group suggests that the tail segment may be the most sensitive region to early metabolic shifts associated with adiposity. In contrast, the pancreatic head, while showing numerical enlargement up to 2.25cm, lacked statistical significance ($P = 0.114$). This regional difference is vital, providing sonographers with a more reliable marker (the tail) when assessing BMI-related changes.

While the overall trend confirms that pancreatic size increases with BMI, the slight decrease in the body segment size in the obese group compared to the overweight group 1.44 cm vs. 1.48cm requires careful consideration. This deviation may hint at a transition from early steatosis-driven swelling to later stages involving fibrosis or atrophy, a pattern documented in advanced metabolic disease. The derived segment-specific reference values provide a crucial baseline, improving the diagnostic accuracy of transabdominal ultrasound in the context of the global obesity epidemic.

CONCLUSION

BMI is significantly associated with increased pancreatic size, particularly in the body and tail segments. These findings provide useful sonographic reference values and highlight the pancreas—especially the tail—as a sensitive indicator of obesity-related morphological change.

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