Original Research Article

ULTRASOUND ASSESSMENT OF PANCREATIC DIMENSIONS IN NORMAL ADULTS IN SOUTH-SOUTH NIGERIA

ABSTRACT

Background: The pancreas can be imaged using ultrasound to provide details on its size, echotexture, ductal anatomy, and surrounding tissues. Diagnostic and interventional procedures can be easily completed quickly and for a low cost.

Objectives: To determine the normal pancreatic dimensions among normal adults, and their relationship with age, sex, height, weight and body mass index.

Subjects and Methods: This descriptive, cross-sectional study was conducted in four health institutions in Bayelsa State, Nigeria between July, 2022 and February, 2023. Data analysis was done using Statistical Product and Service Solutions for Windows® version 25, SPSS Inc.; Chicago, USA. Descriptive statistics (mean, standard deviation, frequency, and percentages) and analysis of variance were done. The cutoff for statistical significance was set at $P<0.05$.

Results: The head of the pancreas was largest with a mean of 2.43 ± 0.58 cm. The age of the sample population had a significant positive correlation with pancreatic head ($r=0.415$, $p<0.05$), body ($r=0.491$, $p<0.05$) and tail ($r=0.105$, $p<0.05$).There was a statistically significant difference in the pancreatic tail dimensions between males and female ($p=0.01$).A negative correlation was observed between height of the participants and the dimensions of the pancreatic head and body. There was a positive correlation between height and pancreatic tail dimensions.

Conclusion: This study has established baseline values for normal range of pancreatic dimensions in healthy males and females for different age-groups in our environment, and also revealed various levels of correlation between pancreatic dimensions and age, sex, height, weight and body mass index (BMI).

Keywords: Pancreas,Ultrasound, Pancreatic dimensions, Age, Sex, Height, Weight, BMI.

INTRODUCTION

"The pancreas is a retroperitoneal organ, which is located at the level of the first and second lumbar vertebrae on the posterior abdominal wall".[1] It is an accessory digestive gland, and has a head, neck, body and tail.[1] The C loop of the duodenum surrounds the head of the pancreas, which is situated on the inferior vena cava and renal vein, while the tail reaches the splenic hilum.[1,2] The body continues slightly upwards and terminates close to the spleen. The neck is a small constriction that joins the head to the body.[1,2]

"The pancreas can be imaged using ultrasound to provide details on its size, echotexture, ductal anatomy, and surrounding tissues. Diagnostic and interventional procedures can be easily completed

quickly and for a low cost. The benefits of ultrasound include its affordability, portability, and lack of ionizing radiation".[3] Ultrasound scan is however, limited by obesity, significant amount of bowel gas and the skills of the operator.[3]

Other imaging techniques for evaluating the pancreas include computed tomography, magnetic resonance imaging, magnetic resonance cholangiopancreatography, and endoscopic retrograde cholangiopancreatography. However, the use of computed tomography and endoscopic retrograde cholangiopancreatography is constrained by the requirement for specialized equipment and associated radiation exposure. Moreover, they are costly and difficult to use on a large population in our setting.

The average anterior-posterior diameter of a normal pancreatic head, body and tail are 34 mm, 29 mm and 32 mm, respectively. The normal length of the pancreas is 12 – 20 cm, while the diameter of the pancreatic duct is ≤ 3 mm.[4] Pancreatitis, pancreatic cyst, carcinoma of the pancreas may all alter the size of the pancreas.[5]

"The pancreas produces exocrine and endocrine secretions. The acinar cells of the pancreas produce pancreatic juice (exocrine secretion), which is secreted into the duodenum through the pancreatic ducts".[1] The islet cells of Langerhans of the pancreas produce insulin and glucagon (endocrine secretions), which are secreted into the blood.[1] Therefore, the objective of this study was to determine the normal pancreatic dimensions among normal adults, and their relationship with age, sex, height, weight and body mass index.

METERIALS AND METHODS

Study design and setting: This descriptive, cross-sectional study was conducted at the Federal Medical Centre, Yenagoa, Niger Delta University Teaching Hospital, Okolobiri, Diete Koki Memorial Hospital, Yenagoa and Silhouette Radiodiagnostic Consultants, Yenagoa, all in Bayelsa State, Nigeria. The study was conducted between July, 2022 and February, 2023. These facilities offer specialised care services to the people of Bayelsa State and nearby Rivers and Delta States, all of which are located in the South-South geopolitical region of Nigeria.

Sample size calculation: The sample size for this study was calculated using the formula:

$n = z^2pq/d^2$ [6]

Where:

n = minimum sample size

z = normal standard deviation set at 95% confidence limit = 1.96

p = proportion in the target population which was 50% (0.5) from a previous study.[7]

q = 1 – p (complementary probability).

d = margin of error = 5% = 0.05

Calculation:

$n = (1.96)^2 \times 0.5 \times 0.5 / (0.05)^2$

$n = 3.8416 \times 0.5 \times 0.5 / 0.0025$

$n = 0.9604 / 0.0025$

$n = 384.16$

After considering attrition of 5%, 'n' was adjusted to 403

Study population: Four hundred and three healthy males and females (students, hospital staff and patient relatives) who were not in the health facilities for health reasons wererecruited and enrolled.
Inclusion criteria: Healthy males and females without any medical condition.
Exclusion criteria: Males and females with pancreatic or liver disease and other medical conditions, chronic alcoholism, pregnant women, those on opioids, have recently undergone a barium meal study and individuals who cannot fast for up to 6 – 8 hours.

The participants for this study were recruited voluntarily. Their sociodemographic information and a brief history were collected to rule out the presence of medical conditions and anything that may affect the size of the pancreas.

Before the ultrasound scan, the participants were asked to fast for at least 6 to 8 hours. The participants were counselled on the examination and study. Their height (in meters) and weight (in kilograms) were recorded. Body mass index (BMI) was determined as the weight in kilograms (kg) divided by height in meters (m) squared. Urinalysis, fasting blood sugar, liver function tests and serum electrolytes, urea and creatinine, were done for the study participants, and if these were normal, they were then referred to the Radiology Units of the study centres for ultrasound scan.

Procedure: Using a 2012 Philips HD11 device with a 3.5 MHz curvilinear probe, consultant radiologists performed transabdominal ultrasound examinations on each patient. To ensure data quality, the consultant radiologists discussed the standard operating procedure for ultrasonography, evaluated it for interobserver variability and reliability, and came to an agreement before data collection started. Each participant was examined in supine position. The pancreas was visualised by transverse and longitudinal upper epigastric, oblique intercostals, and subcoastal sections. The subcoastal sections were mainly used for the head and tail. The pancreas was assessed using sections that passed above the gastric antrum with the transducer positioned high in the epigastrium, or using subgastric sections with the transducer placed approximately halfway between the umbilicus and xiphoid appendix, or using transgastric sections.

High epigastric sections, transgastric sections, and sections using the left lobe of the liver as an acoustic window contributed to the best ultrasound windows being obtained. The antrum (stomach), acting as an acoustic ultrasound window for the pancreas, must be air-free or filled with fluid in order to allow visualization of the pancreas by transgastric sections. For this reason, the practical strategy is to have the participant drink 500 – 700 ml of water 10 – 15 minutes before ultrasound scan. As a result, the stomach will be filled with transonic liquid and become the ideal acoustic window for the pancreas. Measurements were obtained in centimeters (Figure 1) and documented.

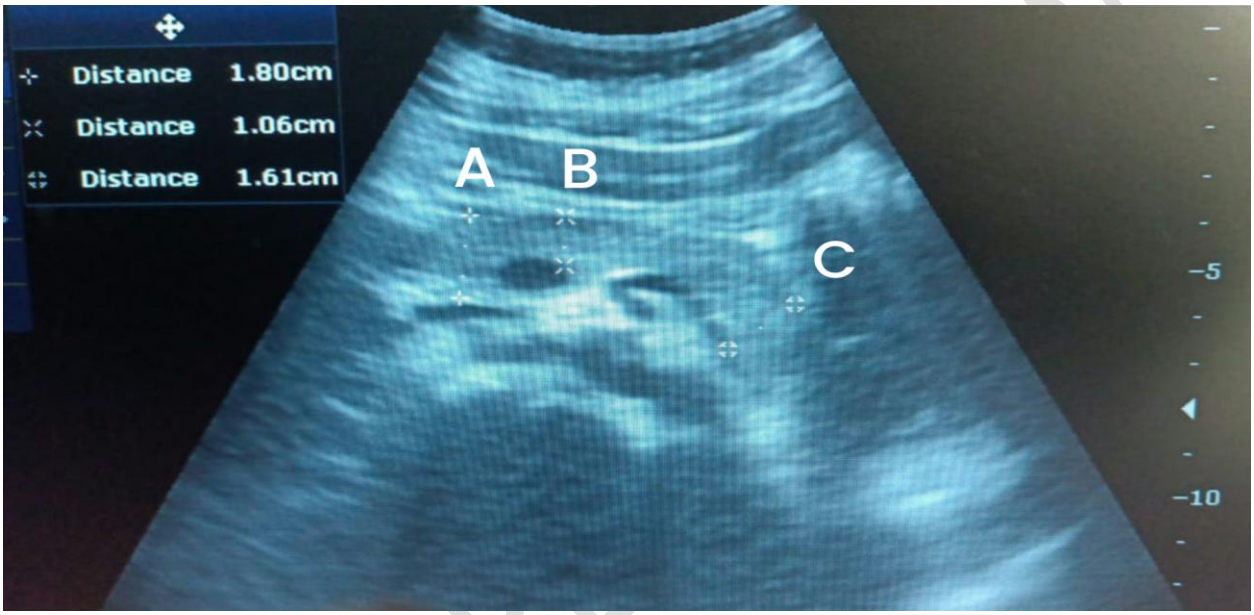

Figure 1: Longitudinal view of the abdomen showing pancreatic dimensions (white dotted lines). A: Head of pancreas (1.80 cm). **B:** Body of pancreas (1.06 cm). **C:** Tail of pancreas (1.61 cm).

Data analysis: The measurements were recorded using a pre-designed proforma. Statistical Product and Service Solutions for Windows® version 25, developed by SPSS Inc. in Chicago, USA, was used for data analysis. The analysis included descriptive statistics (mean, standard deviation, frequency, and percentages).Analysis of variance (ANOVA) was used to establish the relationship between the dimensions of the pancreas and age, sex, height, weight, and body mass index, which was then verified using an independent student t-test. The intraclass correlation coefficient (ICC) was used to calculate and document inter- and intra-observer differences. The cutoff for statistical significance was $P<0.05$.

RESULTS

Four hundred and three participants were involved in this study. There were 262 (65%) females and 141 (35%) males. The age range was 17 – 68 years with a mean of 34.66 ±13.97 years. The age group of 17 – 25 years had 141 (35%) participants, while those > 65 years were 19 (4.7%) (Table 1). Table 2 revealed

the various normal mean dimensions of the pancreas for different age-groups, and the head of the pancreas was largest with a mean of 2.43 ± 0.58 cm.The age of the sample population had a significant positive correlation with pancreatic head (r=0.415, p<0.05), body (r=0.491, p<0.05) and tail (r=0.105, p<0.05) (Table 3).There was a statistically significant difference in the pancreatic tail dimensions between males and female (p=0.01) (Table 4). A negative correlation was observed between height of the participants and the dimensions of thepancreatic head and body. There was a positive correlation between height and pancreatic tail dimensions (Table 5). The weight in the sample population had significant positive correlation with pancreatic body (r=0.134, p<0.05) and tail (r=0.232, p<0.05) (Table 6). The body mass index had a significant positive correlation with the pancreatic head (r=0.131, p<0.05), body (r=0.208, p<0.05) and tail (r=0.189, p<0.05) (Table 7). Table 8 displays the results for the intraobserver and interobserver correlation coefficients.

Table 1: Age range distribution

Characteristics	Frequency, n = 403	Percent
Age group (years)		
17 – 25	141	35.0
26 – 35	120	29.8
36 – 45	80	19.9
46 – 55	20	5.0
56 – 65	23	5.7
> 65	19	4.7

Table 2: Normal mean pancreatic dimensions

Age (years)	Head		Body		Tail	
	n = 403	Mean ± SD	n = 403	Mean ± SD	n = 403	Mean ± SD
17 – 25	141	2.27± 0.44	141	1.05±0.16	141	1.46±0.37
26 – 35	120	2.39±0.39	120	0.95±0.25	120	1.25±0.21
36 – 45	80	2.30±0.78	80	1.10±0.13	80	1.34±0.33
46 – 55	20	3.56±0.12	20	1.11±0.03	20	1.54±0.07
56 – 65	23	2.66±0.31	23	1.30±0.09	23	1.43±0.08
>65	19	3.00±0.00	19	1.60±0.00	19	1.70±0.00
Head of pancreas in cm – mean ± SD				**2.43 ± 0.58**		
Body of pancreas in cm – mean ± SD				**1.07 ± 0.23**		
Tail of pancreas in cm – mean ± SD				**1.39 ± 0.31**		

Table 3: Correlation between pancreatic dimensions with age

Pancreas	Correlation coefficient	P-value
Head	0.415	0.000
Body	0.491	0.000
Tail	0.105	0.036

Table 4: Dimensions in relation to sex

Pancreas	Males	Females	P-value
Head	2.52 ± 0.43	2.38 ± 0.64	0.10
Body	1.07 ± 0.26	1.07 ± 0.21	0.91
Tail	1.52 ± 0.37	1.31 ± 0.24	0.01

Table 5: Correlation between pancreatic dimensions with height

Pancreas	Correlation coefficient	P-value
Head	-0.77	0.121
Body	-0.070	0.161
Tail	0.069	0.164

Table 6: Correlation between pancreatic dimensions with weight

Pancreas	Correlation coefficient	P-value
Head	0.061	0.225
Body	0.134	0.007
Tail	0.232	0.000

Table 7: Correlation between pancreatic dimensions with body mass index

Pancreas	Correlation coefficient	P-value
Head	0.131	0.008
Body	0.208	0.000
Tail	0.189	0.000

Table 8: Interobserver and intraobserver intraclass correlation coefficient results

Ultrasound parameter	Intraclass correlation coefficient	
	Interobserver	Intraobserver
Pancreatic dimensions	0.98 (95% CI 0.52–0.99)	0.99 (95% CI 0.57–0.99)

DISCUSSION

This study was conducted to assess the dimensions of the pancreas, and correlate them with age, sex, height, weight and body mass index. The normal mean dimensions of the pancreatic head, body and tail in our study were 2.43 ± 0.58 cm, 1.07±0.23 cm and 1.39 ± 0.31 cm, respectively. These mean values are in agreement with those of other studies in Lagos, South-West Nigeria[8] and Maiduguri, North-East Nigeria.[7]In this study, increasing age was associated with an increase in the size of the pancreatic head, body and tail. This contrasts the finding of Syed et al., who reported that increasing age was associated with a moderate decrease in the size of the pancreatic body and tail, but the size of the head of pancreas increased up to the age of 71 years.[9]Aliyu observed in his study in Maiduguri, North-East Nigeria, that it was only the size of the pancreatic head that correlated with age.[7] Wang et al., observed that as the age of the male increased, there was an associated initial increase in size of the pancreas, followed by subsequent reduction in size afterwards.[10]These variations may be due to the different sample sizes, age groups and methodology of the various studies.

Our findings revealed no statistically significant difference in the mean pancreatic head and body dimensions in both sexes, but showed a statistically significant difference in the mean pancreatic tail dimension, with the values higher in the male. This was similar to the observation of Aliyu, where there was no statistically significant difference in the mean pancreatic head, body and tail dimensions in both sexes.[7]In contrast to our study, Syed et al., observed that “measurements of the head of pancreas were smaller among women, but the body and tail showed no sex difference”.[9]Another study by Wang et al., revealed that while there was no gender difference in the dimension of the tail, men had much larger pancreatic heads and bodies than females.[10] These variations may also be due to the different sample sizes, age groups, methodology of the various studies, and the physical and genetic constitution of the different people that live around the world.

This study observed that while there was a negative correlation between height of the participants and the dimensions of the pancreatic head and body, there was a positive correlation between height and pancreatic tail dimensions. This is similar to the finding of Aliyu, who observed no positive correlation between height and the dimensions of the head, body and tail of pancreas.[7]However, Raut et al., reported that the mean dimension of every part of the pancreas increased as height increased.[11]The reasons for these variations are not readily understood, but may also be related to the physical and

genetic constitution of the different people around the world, the different sample sizes, age groups and methodology of the various studies.

Our study revealed that the weight and body mass index of the participants had significant positive correlation with the dimensions of the pancreatic body and tail.Aliyu observedthat the dimensions of the head and tailof pancreas correlated with weight, and that the dimensions of the pancreatic head, body and tail had significant positive correlation with body mass index.[7] while Raut et al., reported that the mean dimension forall the three parts of the pancreas increased as weight increased.[11]Body weight and body mass index increase with accumulation of fat. Therefore, this fat may also accumulate on the pancreas, increasing the dimensions of the parts of the pancreas.Pancreatic fat increases with aging and obesity.[12]

In this research, the ICC was used to reduce intraobserver and interobserver variability while measuring pancreatic dimensions. It evaluates the consistency of measurements for the same parameter[13] and considers both the variance of all measurements as well as interobserver variability.[13,14]Almost perfect agreement is indicated by a result above 0.8, with the normal range being 0 to 1.[15,16]The inter- and intraobserver variance results in our research were 0.98 and 0.99, respectively, demonstrating almost perfect agreement.

The multicenter design of this study, which solely enrolled healthy male and female subjects, gives it strength. Confounding variables, such as pancreatic and liver diseases or other medical conditions, that could have affected the measures of pancreatic size were thus excluded. Visualizing the pancreas is made challenging by the presence of gas in the stomach, duodenum and colon. In order to get rid of this gas, the participants were asked to drink water about 15 minutes before ultrasound scan. The pancreas is challenging to visualize in obese people. This was overcome with the use of our high-resolution ultrasound scan machine. The fact that this study is hospital-based and so might not accurately represent what is available to the general community of people is also a limitation.

CONCLUSION

This study has established baseline values for normal range of pancreatic dimensions in healthy males and females for different age-groups in our environment, and also revealed various levels of correlation between pancreatic dimensions and age, sex, height, weight and body mass index. More researches on the relationship between pancreatic dimensions and age, sex, height, weight and body mass index are therefore recommended.

Consent

As per international standard or university standard, Participants' written consent has been collected and preserved by the author(s).

Ethical approval

The protocol for this study was approved by the Research and Ethics Committee of the Federal Medical Centre, Yenagoa, Bayelsa State, Nigeria (FMCY/REC/ECC/2023/696/0279).

COMPETING INTERESTS

Authors have declared that they have no known competing financial interests OR non-financial interests OR personal relationships that could have appeared to influence the work reported in this paper.

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