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# The impact of age on pancreas .A CT based study

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***Abstract :*** *Ethnicity is an important factor known to impact the biology and outcome of many pancreatic diseases. An important feature distinguishing multidetector computed tomography CT is the increased speed of scanning that permits routine use of very thin collimation. The objectives of this study are to establish a population database for pancreas length and width using (CT) scan from ages of 13 to 80years old, as well as to study the impact of age on pancreatic measurements.We measured pancreas length and width in 50 normal subjects with no history of pancreas disease who had undergone abdominal CT scan between 2015 and 2016. Pancreas measured values were computed from the contour of the pancreas on each CT image. In addition to total pancreas measurements, the density was determined by CT Hounsfield (HU).*
*Results showed that during childhood and adolescence, the pancreas measurements and CT(HU) increased linearly with age and then declines thereafter. We provide enduring population highlighting data for pancreatic parenchymal measurements in Sudanese as well pancreatic CT (HU) .*
***Keywords -*** *pancreas, measurements, Computed tomography*

## I. INTRODUCTION

The pancreas is a principally important organ from the point of view of human medicine because it can be affected with two important diseases: diabetes mellitus and pancreatic cancer. Despite this medical importance, the developmental process of the pancreas has attracted only a few numbers of researchers in recent years. [1]
In the investigation of certain lesions of pancreas; the knowledge of normal dimension of the gland was found to be important.[2,3] literature indicated that different studies on the morphometry of pancreas were already done by different researchers .
Determination of pancreas measurements for norms by cross-sectional imaging may be necessary in the acute pancreatitis, initially, and during the course of the disease, in the long term follow-up of chronic pancreatitis, and in diabetic patients.[4,5,6]Reduction of the pancreatic measurements may also affect the exocrine function of the pancreas .[5,7] This also reflects the importance to know the normal size of the pancreas in order to be able to predict any changes that may occur.
The results of previous researches had revealed that the mean length of pancreas was between 12-15cm.[8,9] All these measurements were obtained from various ethnic groups and different geographical situations, but in Sudanese context, few studies had been done till date. Since the ethnicity, body weight, age and nutritional status also affects the size of pancreas [10] and also considering the significance of pancreatic diseases and importance in diagnosis and treatment, it seemed justifiable to carry out a study on the pancreatic morphometry in Sudanese people.

## II. MATERIALS AND METHODS

**Study Design:**
This was descriptive analytical study. It was achieved at radiology department - Royal Care international Hospital and ALzaytona Specialist Hospital (Toshiba 64 slice) during the period from 2015 to 2017.
**CT KUB protocol**
CT scans were performed including protocol of axial images from the xiphoid process covers all abdominal area and pelvic down to pubic bone with patient in supine position, head first. The images were obtained at 100/120 kv and 60/80 mAs, with 5 mm slice thickness. Reconstruction used 3mm to obtain coronal views of KUB. Light diets and fasting for 6 hours was preparation for patient who's undergone CT KUB.
**Inclusion Criteria**
A total of 50 patients were included in this study. Patients were in both genders, 38 were Males constituting 76% and 12 were females and constituting 24%. Patients' ages were <20>60 years old. All were selected for CT KUB. Patients' ages, pancreases CT number, pancreas head size, pancreas body size, pancreas tail size, vertebral body width were all been evaluated.

**Exclusion criteria**:

Patients having pathological changes such as; ascites, retro peritoneal mass, Ca head of pancreas, pancreatitis or any pathology affecting the measurement of the pancreas were excluded.

**Method of Pancreas Measurement**

The measurements were taken from the operator council of the CT machine; the axial images were obtained through the middle of the pancreatic portion (head, body and tail) .Anterior-posterior diameters (AP) were measured at right angles to the longitudinal axis of the organ. The largest diameter of the pancreas lying to the left of the middle of the vertebral body was considered the head .The body of the pancreas was measured on the left margin of the vertebral body and the tail opposite to the medial margin of the left kidney. The transverse diameter of the adjacent vertebral body was measured and used as a reference and marker of body character. The CT numbers for the pancreas head, body and tail were measured in (Hounsfield). Data obtained were entered into a Microsoft Excel spreadsheet and analyzed using Statistical Package for Social Sciences (SPSS) version 16 (SPSS Inc., Chicago, IL, USA).Data statistical test of significance was done with t-test , $P \leq 0.05$ was considered statistically significant. Ethical clearance for this study was obtained from the Ethics and Research Committee of Sudan University of Science and technology.

## III. TABLES AND FIGURES

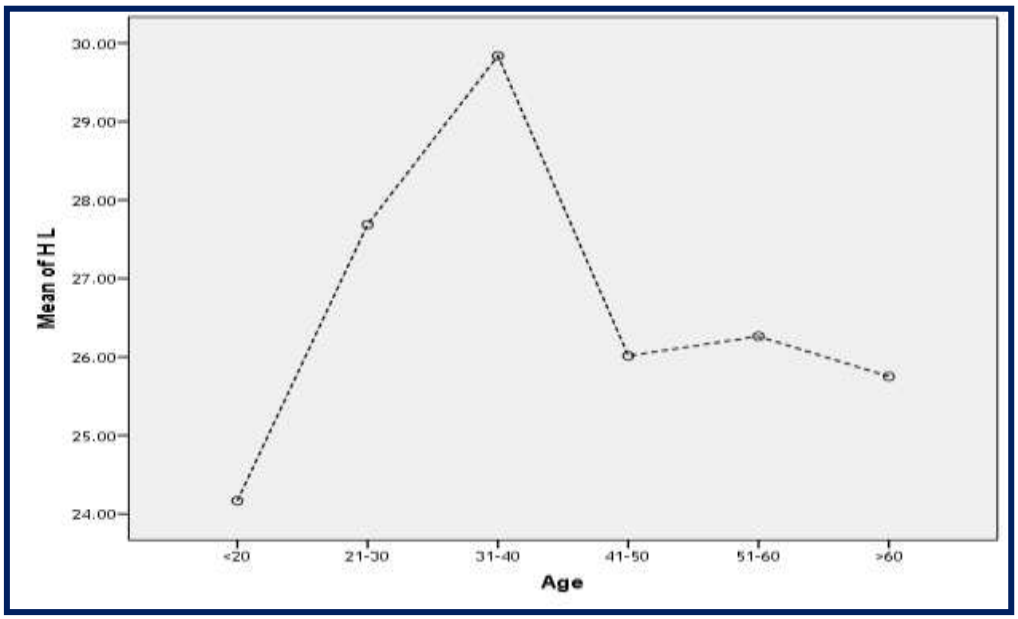
Table 1 : Shows descriptive statistics of Sudanese pancreas measurements classified according to age and P-value

| | | N | Mean | Std. V | Minimum | Maximum | P-value |
|---|---|---|---|---|---|---|---|
| Pancreas Head Length | <20 | 6 | 24.1667 | 3.81768 | 19.70 | 29.60 | 0.054 |
| | 21-30 | 8 | 27.6875 | 5.50414 | 20.90 | 36.30 | |
| | 31-40 | 8 | 29.8375 | 2.45237 | 27.30 | 35.40 | |
| | 41-50 | 14 | 26.0143 | 3.70880 | 20.90 | 33.00 | |
| | 51-60 | 8 | 26.2625 | 4.77701 | 16.50 | 30.70 | |
| | >60 | 6 | 25.7500 | 3.16212 | 20.20 | 29.10 | |
| | Total | 50 | 26.6800 | 4.17515 | 16.50 | 36.30 | |
| Pancreas Head width | <20 | 6 | 20.2000 | 4.19190 | 17.20 | 28.40 | 0.010 |
| | 21-30 | 8 | 25.1750 | 4.22061 | 20.60 | 31.70 | |
| | 31-40 | 8 | 27.7875 | 4.03925 | 23.70 | 36.70 | |
| | 41-50 | 14 | 23.2714 | 3.06128 | 18.70 | 28.50 | |
| | 51-60 | 8 | 21.6625 | 5.66391 | 15.00 | 32.70 | |
| | >60 | 6 | 26.9167 | 4.89588 | 20.60 | 33.60 | |
| | Total | 50 | 24.1100 | 4.75314 | 15.00 | 36.70 | |
| Pancreas body Length | <20 | 6 | 56.7167 | 9.80111 | 48.40 | 72.30 | 0.004 |
| | 21-30 | 8 | 70.7000 | 10.55002 | 57.20 | 85.90 | |
| | 31-40 | 8 | 76.2500 | 10.19313 | 57.80 | 90.30 | |
| | 41-50 | 14 | 71.1714 | 8.06783 | 59.00 | 87.80 | |
| | 51-60 | 8 | 69.1625 | 6.39976 | 57.30 | 79.90 | |
| | >60 | 6 | 65.2500 | 5.04411 | 59.00 | 71.00 | |
| | Total | 50 | 69.1420 | 9.84088 | 48.40 | 90.30 | |
| Pancreas body width | <20 | 6 | 16.8500 | 4.42527 | 13.00 | 24.00 | .012 |
| | 21-30 | 8 | 19.8125 | 6.11402 | 13.60 | 29.10 | |
| | 31-40 | 8 | 26.3125 | 4.00765 | 20.00 | 31.40 | |
| | 41-50 | 14 | 23.7214 | 4.62638 | 16.70 | 34.50 | |
| | 51-60 | 8 | 21.3500 | 5.65483 | 16.00 | 29.80 | |
| | >60 | 6 | 20.4167 | 4.36322 | 13.20 | 24.70 | |
| | Total | 50 | 21.9100 | 5.48650 | 13.00 | 34.50 | |
| Pancreas tail Length | <20 | 6 | 27.9500 | 2.60979 | 24.80 | 32.30 | 0.054 |
| | 21-30 | 8 | 35.0125 | 5.30537 | 27.60 | 40.20 | |
| | 31-40 | 8 | 37.7250 | 6.78670 | 28.40 | 51.00 | |
| | 41-50 | 14 | 35.2357 | 5.57517 | 25.60 | 45.90 | |

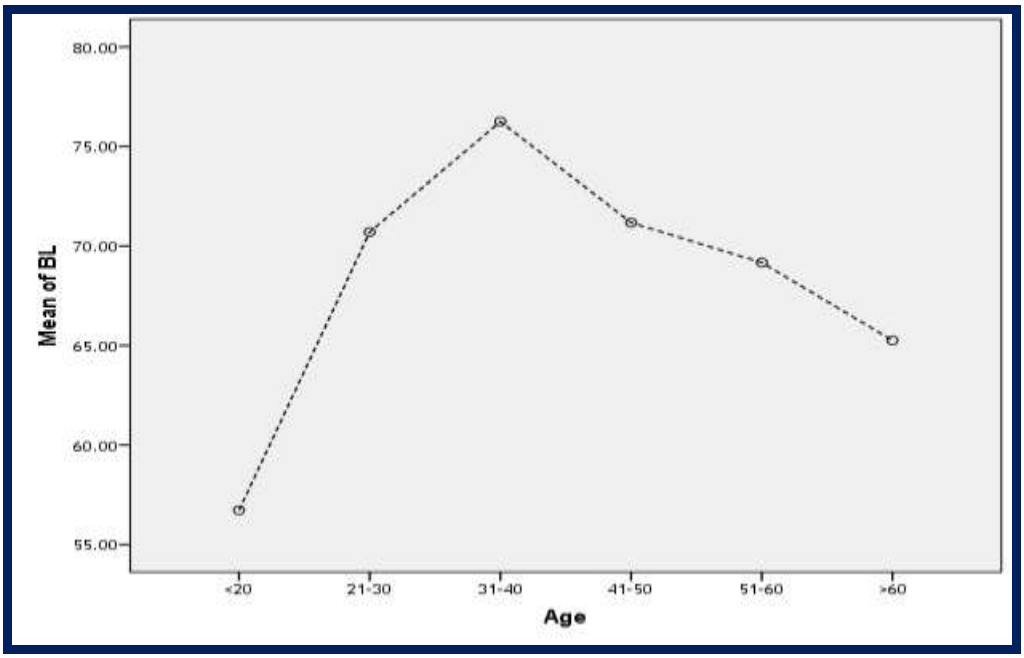
| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 51-60 | 8 | 34.6750 | 1.88509 | 33.00 | 37.60 | |
| | >60 | 6 | 34.8833 | 10.41718 | 26.10 | 54.60 | |
| | Total | 50 | 34.5920 | 6.18761 | 24.80 | 54.60 | |
| Pancreas tail width | <20 | 6 | 14.9000 | 5.28507 | 7.00 | 21.50 | 0.058 |
| | 21-30 | 8 | 17.1125 | 5.30510 | 12.10 | 28.00 | |
| | 31-40 | 8 | 21.1625 | 2.39221 | 18.00 | 24.80 | |
| | 41-50 | 14 | 21.6429 | 4.99426 | 15.40 | 32.00 | |
| | 51-60 | 8 | 18.7500 | 6.36800 | 10.90 | 26.00 | |
| | >60 | 6 | 17.1167 | 6.87820 | 9.90 | 24.50 | |
| | Total | 50 | 19.0260 | 5.54701 | 7.00 | 32.00 | |

Table 2: Shows descriptive statistics of pancreas, and vertebral CT (Hounsfield) classified according to age and P-value

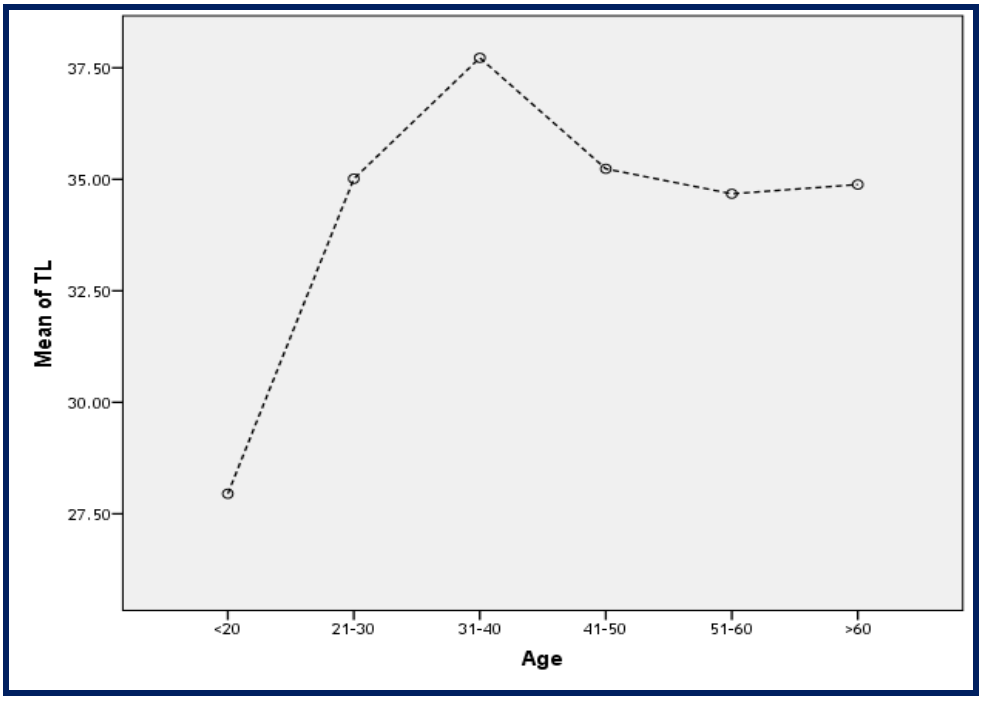
| | | N | Mean | Std. V | Minimum | Maximum | P-value |
|---|---|---|---|---|---|---|---|
| Pancreas CT No | <20 | 6 | 59.8333 | 4.70815 | 52.00 | 65.00 | 0.000 |
| | 21-30 | 8 | 58.8750 | 5.86606 | 54.00 | 68.00 | |
| | 31-40 | 8 | 54.8750 | 8.18426 | 43.00 | 66.00 | |
| | 41-50 | 14 | 46.7857 | 6.11654 | 39.00 | 56.00 | |
| | 51-60 | 8 | 47.2500 | 4.36708 | 41.00 | 55.00 | |
| | >60 | 6 | 45.5000 | 5.75326 | 40.00 | 55.00 | |
| | Total | 50 | 51.5000 | 8.10706 | 39.00 | 68.00 | |
| Vertebra CT No | <20 | 6 | 32.3667 | 4.12246 | 28.20 | 37.70 | 0.008 |
| | 21-30 | 8 | 37.8125 | 4.32648 | 32.30 | 45.00 | |
| | 31-40 | 8 | 40.9875 | 2.73362 | 36.40 | 44.30 | |
| | 41-50 | 14 | 36.3714 | 3.74195 | 31.10 | 43.70 | |
| | 51-60 | 8 | 38.6375 | 4.92456 | 31.00 | 47.60 | |
| | >60 | 6 | 40.3000 | 6.09852 | 34.20 | 51.40 | |
| | Total | 50 | 37.6940 | 4.81407 | 28.20 | 51.40 | |



**[A]**




**[B]**




**[C]**

**Figure (1)A,B,C: shows the relation between the subjects ages classified into age classes and {A}pancreas head ,{B}body and {C}tail length{HL,BL,TL}**

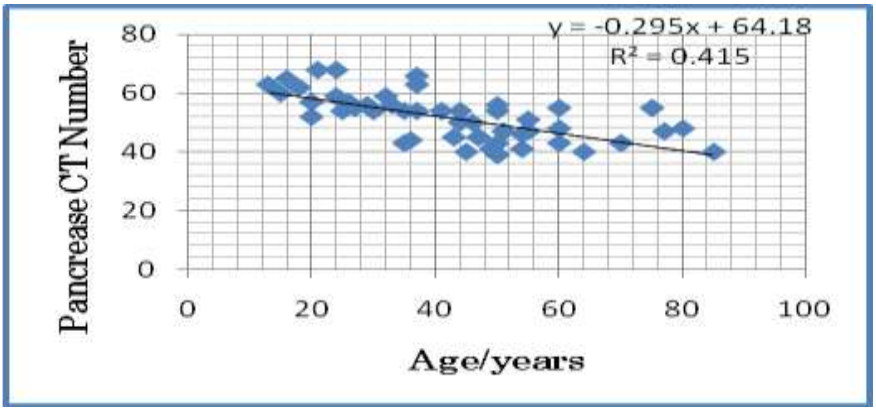



**Figure (2) shows the relation between the subjects ages and pancreas CT(HU)**

## IV. DISCUSSION

Pancreata were identified based on the typical landmarks including splenic vein, superior mesenteric artery as mentioned by Geraghty et al.[11].

Mean pancreatic measurement in the presented series of 50 adults was seen in table (1). A wide range of the pancreatic measurements for head, body and tail width and length values were observed.

Mean normal pancreas measurement by computed tomography in the first reported series of 41 pancreases, was 40.4 ± 9.3 $cm^3$ [12], which was larger than what was found in our series.

A smaller investigated group, possibly different, age, and anthropometric characteristics of subjects may be the reasons for such difference as mentioned by Schulz et al. [12] .Geraghty et al. [11] reported results concerned with pancreas measurements in normal subjects .Moderately less mean pancreatic measurements in the Japanese series than in the series of Geraghty et al. was found. This might be explained by different anthropometric characteristics of the Japanese population, in comparison to Europeans.

Anterior–posterior (AP) diameters of the tail, body, and head of the pancreas are the most widely used measuring diameters for the determination of pancreatic size by the cross-sectional imaging methods: ultrasonography (US), computed tomography (CT), and magnetic resonance imaging (MRI). Cranial–caudal (CC) dimensions are also measurable, but rarely used in regular clinical practice. [13]

The length of the pancreas measured by CT was reported in two available studies, but the methodology of measurement was different in each study [2,12]. AP diameters of the pancreas in our series: 18.7 ± 4.7mm, 21.4 ± 5.0mm, and 28.0 ± 5.5 mm for the tail, body, and head, respectively, were compatible with the values reported in the literature [12,14,15,16] and the head length was 36.30,body length was 90.30 and tail length was 54.60 mm

There are differences in the measurements when compared with the available reported data [12,15].Mean length of the pancreatic body and tail in one series was 105 ± 18 mm. That was reported in the study of Acar et al. [2] whom measurements differ from the measurements done by [13] which was found to be 90.5 ± 12.2 mm, whilst this measurements are less than the Sudanese results (body and tail length was 144.90mm).Our justification may be due to authors measurement methods at the transversal projection of the length of body and tail, which normally lie in oblique direction. This was also reasonably mentioned by study done previously [13]

Strong correlation between the measurement of the pancreas, CT number of pancreas, and vertebra with age was found, this was noticed in Table2. We established a new equation for measuring the CT number of pancreas for a subject with known age ;in the formula: **(pancreas CT Number =-0.295x age +64.18).**The use of the proposed formula, which includes commonly measured diameters of the pancreas by cross-sectional imaging, will provide fast calculation of the approximate pancreatic CT number in the regular clinical practice. This could be particularly useful if automatic countering software for CT measurements is unavailable.

The current study used the CT numbers for the pancreas as well as the CT number of vertebra as references which is similar to the method done by Afraa,et al 2013[17] in order to evaluate the changes that may happen due to increasing age. The justification to have relation with age, could be due to decline in the glandular tissue as well as the fatty connective tissue within the substance of the gland in elderly people and thinning atrophy of the gland .[17,18]

One study has mentioned that there is no statistically significant correlation found between the measurement of the pancreas and the age of individuals, although tendency of pancreas measures decrease with the increasing age. Saisho et al. [19] found that the measurement of the pancreas was not age dependent within the years 20–60, yet in older individuals the pancreatic measures was gradually decreased as age increased. Study of Heuck et al. [20] reported that dimensions of pancreas were age related: pancreas decreased in size as age increased. This was also confirmed in our series (Figures 1,2). The impact of age on pancreas measurements was studied previously [17,21]. Our study findings were not consigned with most of these results. Other results had mentioned that parenchymal

pancreatic measurements have reached a maximum in the third decade of age, remaining constant until 60 years of age thereafter and it gradually decreases [17,21]. However the study in Sudanese pancreas size was best described by the established age related formula.

One study had also reported that in adults beyond 60 years of age, both total and parenchymal pancreas measurements gradually decline and fat infiltration of the pancreas have been reported with aging in humans [22,23] this is why the CT

number in our study is decreased by increasing age (Figure 2). Previous anatomical studies reported that pancreas measurements decreased after age 60 (17, 24,25)

The vertebra CT number was found to be increased with age; our justification is due to calcium deposition on bones due to increasing age.

Unfortunately, the important anthropometric data, height and weight of the subjects, were not available because these values were not recorded in their medical records, which is a serious drawback of our study. Thus, we were not able to analyze the correlation between the measurements of the pancreas and height, weight, body mass index (BMI), and body surface area (BSA) of subjects, as it was done in the other published studies.[11,26]

## V. CONCLUSION

Considerable individuals variations in the measurements of normal pancreas, measured by CT in the adult Sudanese population were observed in the presented study; It has been confirmed that pancreatic measurements is related to the individual's age.We found that, by means of presented formula the pancreas measurement could be estimated using a simple linear measurements and enables fast calculation of an approximate pancreas. In our opinion, it could be useful in regular practice if automated software for the CT is not available for the initial and follow-up assessment of the pancreas in many pathological conditions.

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