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REEVALUATION BODY WEIGHT AND AGE WITH STANDARDIZED UPTAKE VALUE IN THE LIVER CANCER FOR [^{18}F] FDG PET/CT†

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Standardized uptake values, often known as SUVs, are frequently utilized in measuring ^{18}F-fluorodeoxyglucose (FDG) uptake in malignancies. In this work, we investigated the relationships between a wide range of parameters and the standardized uptake values (SUV) found in the liver. Examinations with ^{18}F-FDG PET/CT were performed on a total of 59 patients who were suffering from liver cancer. We determined the SUV in the liver of patients with a normal BMI (between 18.5 and 24.9) and a high BMI (above 30) obese, after adjusting each SUV based on the results of the body mass index (BMI) and body surface area (BSA) calculations, which were determined for each patient based on their height and weight. Under various circumstances, SUVs were evaluated based on their means and standard deviations. Scatterplots were created to illustrate the different weight and SUV variances. In addition to that, the SUVs that are appropriate for each age group were determined. SUVmax in the liver was statistical significance in obese BMI and higher BSA, p-value < 0.001). Age appeared to be the most important predictor of SUVmax and was significantly associated with the liver SUVmax with mean value (58.93±13.57). Conclusions: Age is a factor that contributes to variations in the SUVs of the liver. These age-related disparities in SUV have been elucidated due to our findings, which may help clinicians conduct more accurate assessments of malignancies. However, the SUV overestimates the metabolic activity of every individual, and this overestimation is far more severe in people who are obese compared to people who have a body mass index that is normal (BMI).
Keywords: ^{18}F-FDG-PET/CT); Standardized Uptake Value (SUV); Liver; BMI; Age Variation
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1. INTRODUCTION

In the present day, (^{18}F-FDG) PET/CT scan is frequently used for staging, restaging, recurrence identification, and tracking of therapeutic response in a variety of malignant diseases [1]. ^{18}F-FDG PET/CT identifies malignant lesions by combining metabolic and anatomical information. To accomplish this, areas with rapid glycolytic metabolism and expression of membrane glucose transporter (GLUT) proteins are located and mapped out [2]. Malignant lesions aren't the only type of lesion that can have increased FDG uptake; infections and inflammatory lesions can also have this effect. Therefore, various more lesions that may demonstrate FDG uptake could be located in the head, neck, lung, mediastinum, belly, pelvis, bones, joints, lymph nodes, or vascular system [3].

Studies on the benefits and drawbacks of various methods of assessing tissue ^{18}F FDG accumulation on PET/CT, such as glucose utilization rate (MRglu) [4], FDG clearance, and standardized uptake value, have been carried out in a number of different instances. Examples of these methods include glucose utilization rate (MRglu) (4). (SUV). The parameter SUV, which quantifies the amount of tissue FDG concentration per FDG unit, is the one that is used the most often and the most widely [5].

As a practical and semiquantitative indicator for FDG accumulation in tissue, the standardized uptake value (SUV) has been presented as a useful tool. To determine it, divide the patient's body weight by the ratio of the amount of activity present in the tissue per milliliter to the amount of activity contained in the injected dose [6]. The distribution absorption ratio, often known as the SUV, goes by a few distinct names. One of them is the differential uptake ratio [7,8].

On the other hand, mistakes in liver SUV could be the result of a number of different physiologic factors. These factors, which also include age, gender, body mass index, serum glucose level, hepatic function, and hyperthyroidism, might lead to inaccurate PET/CT findings that are either false-positive or false-negative [9]. Therefore, in order for medical professionals to properly interpret PET/CT images of the liver, it is necessary to first determine the normal SUV of the liver. According to an increasing number of studies, an SUV's age may have a major impact on its performance. It is essential to provide scientific rigor and enable repeatability by determining a precise range of liver SUVs using ^{18}F-FDG PET/CT in multi-aged groups [10].

Despite the fact that many researchers have used SUV as a useful semiquantitative indicator for evaluating FDG uptake in tissue, it was recently shown that SUV has a substantial positive association with patient body weight, rising by 70%-98% from patients with low weight to those with high weight. This discovery was made despite the fact that many researchers have been using SUV in this capacity. Despite the fact that a large number of researchers have been used SUV as a helpful semiquantitative indicator for evaluating FDG uptake in tissue, this was found to be the case [11].

The purpose of this study was to examine the association between age and body weight and standardized uptake value in liver cancer patients.

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2. MATERIALS AND METHODS

Between November 2022 and December 2022, participants aged 15 to 85 were referred to the Al-Andalus Specialist Hospital. The study included 59 participants (24 male and 35 female) individuals. The participants' average age was 58.01 ± 13.18 years. The hospital's ethical committee accepted our study, and informed patient consent was obtained prior to doing PET/CT scans.

In the course of our investigation, we made use of a Discovery IQ PET/CT scanner (GE Healthcare, Milwaukee, WI, USA). This scanner's detector was made up of Bi4Ge3O12 (BGO) crystals, each of which measured 6.3 by 6.3 by 30 millimeters. At the one-bed position, the transaxial field of vision (FOV) measured 700 millimeters, the axial field of view measured 260 millimeters, and 79 axial slices were acquired. The window width for the energy range was 435-650 keV, and the window width for the coincidence time range was 9.5 ns. We obtained a matrix with a dimension of 192 by 192, and the thickness of each slice was 3.27 millimeters. The amount of slice overlap that occurred between beds was 19 slices.

Patients who had had a blood sugar concentration in their fasting blood that was more than 200 mg/dL at the time of the examination were not permitted to take part in any aspect of the study. Before receiving an injection of ^{18}F-FDG, all of the patients went without food for at least four to six hours. Before giving ^{18}F-FDG to the patient, an intravenous cannula was put in the patient's arm or hand, and a blood sample was obtained to determine the patient's glycemia.
Images were taken 45–90 minutes following injection of the FDG. Patients were placed in a supine position with both of their arms elevated. The emission acquisition time per bed position was (1.5-3) minutes. By collecting or calculating these characteristics for each patient, the association between patient-dependent factors and ^{18}F-FDG PET image quality was studied. Height and body mass index (BMI) were retrieved from patient data. Determine the body mass index (BMI).

$$\mathrm{BMI} = \frac{\text{weight in kg}}{(\text{height in m})^2}. \tag{1}$$

The World Health Organization categorizes body mass index (BMI) as follows: underweight (BMI 18.5 kg/m^2), normal (18.5 – 24.99 kg/m^2), overweight (25 – 30 kg/m^2), and obese (≤ 30 kg/m^2) [12].

Using the following formula, the body surface area (BSA) was calculated [13].

$$\mathrm{BSA(m^2)} = (\text{weight in kg})^{0.425} \times (\text{height in m})^{0.725} \times 0.007184. \tag{2}$$

2.1. Statistical Analysis

To express all results, the mean and standard deviation (SD) were utilized. All statistical analysis was performed using Microsoft Office Excel 2013. The definition of statistical significance was a p-value less than 0.05.

3. RESULTS

The relationships between SUV and patient body weight are shown in Figure 1. There was statistically significant difference between the SUV and patient body weight ($p < 0.001$). The mean values and SD for body weight (kg) were 78.19 ±16.18.

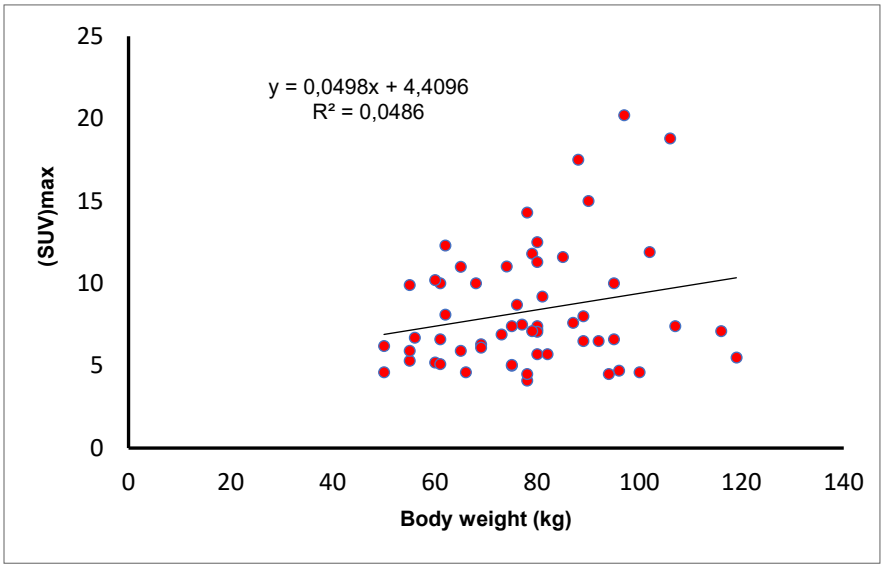

Figure 1. Relationships between patient body weight and SUV.

Statistically significant positive associations existed between BMI and SUVmax ($R^2 = 0.122$, $p < 0.0001$), as shown in Figure 2.

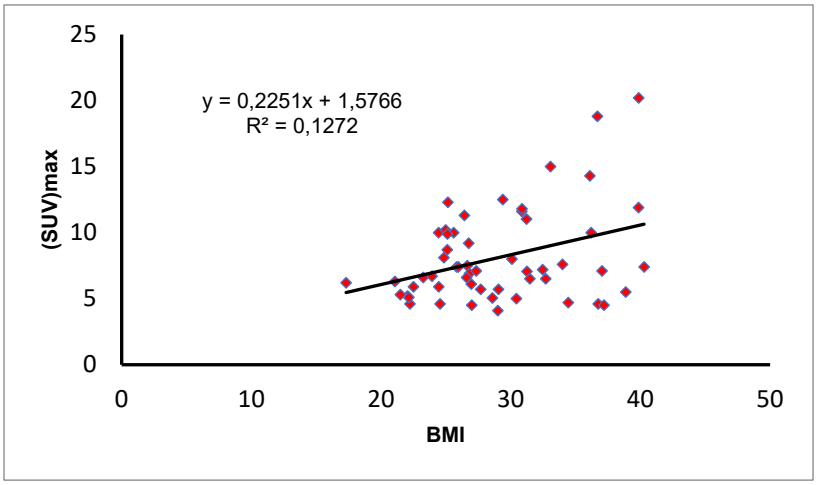

Figure 2. Relationships between BMI and SUV.

Mean BSA was 0.065 ± 0.0070 m^2. The results of the curve fitting of SUV and BSA shows for curve the ($R^2 = 0.0141$) with significant difference ($p < 0.0001$) (see Fig. 3).

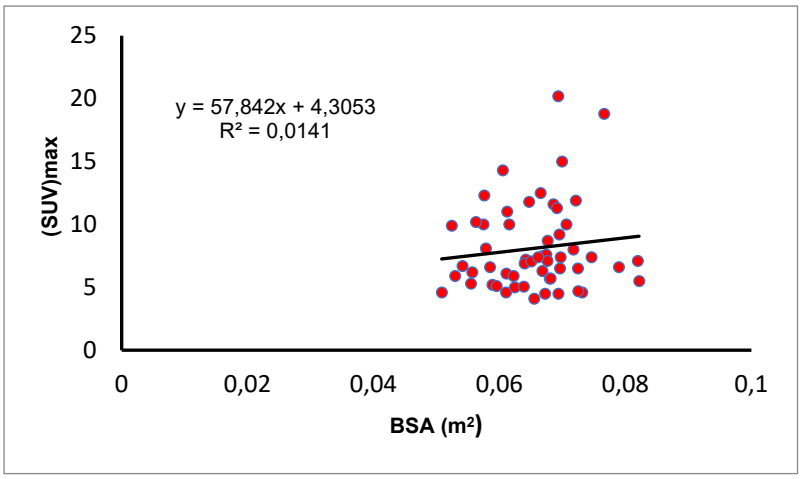

Figure 3. Relationships between BSA and SUV.

When we plotted the SUVmax versus patient age, there was a strong (and significant) $p < 0.001$) (Fig. 4).

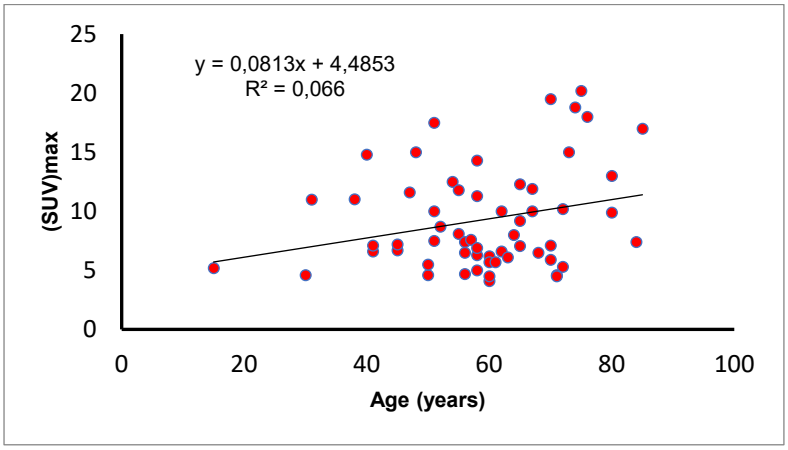

Figure 4. Relationships between age and SUV.

4. DISCUSSION

Visually evaluating PET scans for regions of abnormal uptake is accurate and sufficient. However, depending on the PET investigation, a quantitative or semiquantitative technique can analyze factors such as metabolic activity, perfusion, and receptor density of lesions and tissues more precisely. These assessments are essential for establishing the grade of the cancer, determining the therapeutic agent dosage, and comparing post-treatment with pre-treatment studies [14].

SUV is the most common PET parameter used to evaluate radiopharmaceutical absorption in malignancies and healthy tissues. Although SUV can be affected by a variety of human, biological, and technological factors that could cause an overestimation or underestimating of activity, it nevertheless reliably predicts the degree of absorption in lesions and normal tissues. Suboptimal patient preparation, high blood sugar and insulin levels, diabetes, body mass index, age, sex, the time of imaging after radiotracer injection, significant extravasation of activity, the image acquisition and reconstruction parameters, circumstances during the post injection uptake period, and inaccurate entry of patient weight, height, and injected activity can all affect ^{18}F-FDG uptake [9].

The liver deoxyglucose metabolism of adolescents is significantly lower than that of adults. The increase in ^{18}F-FDG uptake during development may be a result of age-related alterations in hepatocyte quantity, number, and function [15]. A rise in ^{18}F-FDG uptake may also be explained by the substantial changes in body size, body composition, and blood volume that occur during development. In addition to body size and age, changes in uptake duration, plasma glucose, recovery coefficient, and partial volume artifacts affected SUV results [16]. Meier and colleagues postulated, however, that age-related hepatotoxins may have triggered cumulative inflammatory changes [17].

There are numerous possible biological causes for the observed age-related SUV changes in our study. We hypothesize that organ degeneration, organ metabolism, and molecular transport could explain the pertinent mechanisms. In overweight and obese patients, SUV is typically overstated in lesions and normal tissues; in heavy patients, SUVs of liver were up to twice as high as those in lighter patients (figure 1). Both body surface area and body mass index were calculated on the basis of patient body weight and height; there was a strong positive correlation between both indices with SUV, Figures 2 and 3.

5. CONCLUSION

SUV overestimates metabolic activity in all patients, although the effect is particularly pronounced in obese individuals. Age was found to have the greatest effect of all the variables that influence the liver SUV. We discovered age-related changes in the physiological absorption of FDG by the liver. Before analyzing oncologic whole-body PET/CT scans, it must be proven that the liver's background SUV is within the age-dependent reference limits.

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ПЕРЕОЦІНКА МАСИ ТІЛА ТА ВІКУ ЗА СТАНДАРТИЗОВАНИМ ЗНАЧЕННЯМ ПОГЛИНАННЯ ПРИ РАКУ ПЕЧІНКИ ДЛЯ [^{18}F] FDG PET/CT

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Стандартизовані значення поглинання, часто відомі як SUV, часто використовуються в процесі вимірювання поглинання ^{18}F-фтордезоксиглюкози (FDG) при злоякісних пухлинах. У цій роботі ми досліджували зв'язки між широким діапазоном параметрів і стандартизованими значеннями поглинання (SUV), виявленими в печінці. Обстеження за допомогою ПЕТ/КТ ^{18}F-FDG проведено 59 пацієнтам, які страждали на рак печінки. Ми визначали SUV у печінці пацієнтів із нормальним ІМТ (від 18,5 до 24,9) та високим ІМТ (вище 30) із ожирінням. Після коригування кожного SUV на основі результатів розрахунків індексу маси тіла (ІМТ) і площі поверхні тіла (ППТ), які визначали для кожного пацієнта на основі їх росту та ваги. За різних обставин позашляховики оцінювали на основі їх середніх значень і стандартних відхилень. Діаграми розсіювання були створені, щоб проілюструвати різні відхилення ваги та SUV. Крім того, були визначені позашляховики, які підходять для кожної вікової категорії. SUVmax у печінці був статистично значущим при ІМТ із ожирінням та вищим BSA, p-значення <0,001). Вік виявився найважливішим предиктором SUVmax і був суттєво пов'язаний із SUVmax печінки із середнім значенням (58,93±13,57). Висновки: вік є чинником, який сприяє змінам SUV печінки. Ці вікові відмінності в SUV були з'ясовані в результаті наших висновків, що може допомогти клініцистам у більш точному оцінюванні злоякісних новоутворень. Однак SUV переоцінює метаболічну активність кожного окремого індивідуума, і це переоцінка є набагато серйознішим у людей з ожирінням порівняно з людьми з нормальним індексом маси тіла (ІМТ).

Ключові слова: *^{18}F-FDG-PET/CT); стандартизоване значення поглинання (SUV); печінка; ІМТ; вікова варіація*