International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

The Effect of Blood Glucose Level and Body Mass Index on Standardized Uptake Value on PET/CT

Esra Salam[1], Mohamed Alfadil[2]

Abstract: ***A review of Introduction: In malignant tissue and healthy organs in 18F - FDG PET/CT, glucose metabolism and physiological factors interact to affect 18F - FDG absorption. The present work evaluates on 18F - FDG absorption in tumors and biodistribution in normal tissues of organs the effects of blood glucose levels (BGL), Body mass index, and FDG dosage. Procedures: Analyzed in 99 individuals (43 male - 56 female), 18F - FDG PET/CT shows mean age of 67.6 years with BGL ranging from 130 to 200 mg/dl and body mass index ranging from 18.3 to 46.4. Measuring the target organs (brain, liver, spleen, and heart), we found their mean standardized uptake value (SUV). For statistical relevance, variations in SUV among patients with varying BGLs, BMI, FDG, heigh, weight, and age were examined and matched. Results: Brain_SUV improves with increasing FDG_dose. FDG dosage and Heart SUV The study of this table revealed a strong link between glucose level and heart SUV; hence, the outcome of this table indicated that patient weight has a major influence on liver SUV. (P value.016) The data show a strong association between spleen SUV and glucose level. (p - value.032) Age and brain SUV show a clear link, according to the results. (P - value.002). Conclusion: SUV values in several organs are greatly influenced by FDG dosage. Brain SUV rises with FDG dosage. As FDG dose rises, heart and liver SUV drop. Glucose levels lower SUV in the spleen and the heart. suggests in these areas an inverse link between glucose metabolism and FDG absorption. Variations in SUV are influenced by physical characteristics including age, height, weight, BMI. Senior citizens have smaller brain SUV. Taller people have lower SUV in the brain and spleen. Greater SUV in the liver corresponds with increased weight and BMI.***

Keywords: Blood glucose level, body mass index, flourodeoxy glucose.

1. Introduction

Using deoxy - 2 - [18F] fluoro - D - glucose (18F - FDG) and positron emission tomography (PET), elevated glucose metabolism in malignant tissue has been investigated; its clinical usage for differential diagnosis, staging, and monitoring the therapy of various malignancies has extended globally (Büsing et al.2012). Images are examined subjectively in clinical practice either semiquantitatively utilizing standardized absorption values (SUVs) or visually compared between the metabolism in lesions and in normal tissues. Often utilized as an internal benchmark for tracer absorption, 18F - FDG absorption in normal tissues is cited in assessing tumor treatment with PET (Sprinz et al.2018). Once absorbed by the cells, hexokinase or glucokinase enzyme phosphorytes 18F - FDG into 18F - FDG - 6 - phosphate. Because 18F - FDG - 6 - phosphate minimally passes through subsequent metabolism (glycolysis or the tricarboxylic acid cycle) and its dephosphorylation rate is inefficient, it is mostly retained in the cells. Cancers particularly show either poor or missing dephosphorylation (3). After being absorbed by the cells, 18F - FDG is quickly released in the liver, though, and this is thought to be owing to how rapidly glucose - 6 - phosphatase activity dephosphorylates 18F - FDG - 6 phosphate back into 18F - FDG (Sarikaya et al.2019).

2. Materials and Methods

Designed as a retrospective single center study, this one was carried out at King Khalid University Hospital in Riyadh, Kingdom of Saudi Arabia. Patients who received FDG PET - CT between August 2021 and 2023 were considered qualified for this study; 99 people, 43 men and 56 women made up this total. All patients were instructed to fast for at least six hours before their scan; their ages ranged from 24 to 93 years. Of the 99 patients (43 male and 56 female) all presenting for a PET/CT scan, the study included them in relation to the inclusion criteria. Blood glucose levels were recorded just before the FDG infusion. Patients underwent a 5 - 10 second interval intravenous injection of 370 - 740 MBq FDG. Using a GE Discovery VCT scanner, multi - staction 3 - dimensional (3D) PET acquisition with CT, for attenuation correction, was conducted for about 60 min following an absorption time of approximatively 1 hour in a calm room at rest. Following the CT scan, PET pictures were obtained using the 3D acquisition mode at two minutes per bed position. Reconstructed CT scans then fit a 512 x 512 matrix. Two iterations of a conventional full body 3D iterative reconstruction employing attenuation correction, decay correction, and scatter correction rebuilt PET images onto a 128 × 128 matrix. The range of photon energy was 425–650 keV. Reconstruction diameter was 70 cm and slice thick - ness was 3.27 mm. With spatial resolution of 5 mm, pixel size was 5.47 mm x 5.47 mm.

Measurement done and image interpretation

All PET images were reviewed and further analyzed using the Agfa Impax software by a board certified academic nuclear medicine physician. SUV of the dominant organs (Brain - Liver –spleen and Heart) was obtained by manually placing a square ROI at the site of the maximum FDG uptake in the PET images and the maximal activity (SUVmax) was recorded. SUVmax was calculated as decay - corrected activity of tissue volume (kBq/mL) /injected FDG activity per body mass (kBq/g). SUVbmi was calculated from SUVmax by normalizing activity based on body mass index (BMI) = Weight (kg) /Height2

Method of data analysis for data of texture analysis method

The Obtained data were transferred to (ANOVA) SPSS (ver.16.0) program and were analyzed and presented as mean, standard deviation, Differences were analyzed by the paired T - test and considered to be significant at a *P* - value less than 0.05. Since the sensitivity and specificity of a test depends on the selected threshold value

3. Results

Table 1: Correlation between FDG dose and Brain SUV ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.763	1	14.763	11.067	.001[a]
	Residual	129.392	97	1.334		
	Total	144.155	98			

Table 2: The correlation between FDG dose and start dose) ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	23.697	1	23.697	30.469	.000[a]
	Residual	75.440	97	.778		
	Total	99.137	98			

Table 3: Correlation between Glucose level, FDG dose and Heart SUV ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	17.757	1	17.757	4.466	.037[a]
	Residual	385.694	97	3.976		
	Total	403.451	98			
2	Regression	35.129	2	17.565	4.578	.013[b]
	Residual	368.321	96	3.837		
	Total	403.451	98			

Table 4: The correlation between Wight, Age and Liver SUV ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.384	1	2.384	6.020	.016[a]
	Residual	38.415	97	.396		
	Total	40.799	98			
2	Regression	3.958	2	1.979	5.157	.007[b]
	Residual	36.840	96	.384		
	Total	40.799	98			

Table 5: The correlation between Glucose level and spleen SUV ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	4.181	1	4.181	**4.744**	**.032[a]**
	Residual	85.488	97	.881		
	Total	89.669	98			

Table 6: The correlation between Age, hightand brain SUV ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.219	1	15.219	**10.408**	**.002[a]**
	Residual	141.837	97	1.462		
	Total	157.056	98			
2	Regression	28.124	2	14.062	**10.470**	**.000[b]**
	Residual	128.933	96	1.343		

Table 7: The correlation between the FDG dose, body mass index and liver SUV ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	2.528	1	2.528	6.658	.011[a]
	Residual	36.835	97	.380		
	Total	39.364	98			
2	Regression	4.795	2	2.398	6.659	.002[b]
	Residual	34.568	96	.360		
	Total	39.364	98			

4. Discussion

This study shows dataset presents descriptive statistics for a set of physiological and metabolic parameters in a study population. The total 99 patient (43 female and 56 male), It includes demographic details such as age (mean 67.6 year), weight (mean 72.4 KG), height (mean 167.2 cm), and BMI (mean 26.7), along with metabolic imaging parameters like Standardized Uptake Values (SUV) for the brain (mean 7.3), heart (mean 4.4), liver (mean 3.6), and spleen (mean 2.8) Additionally, the dataset provides information on the administered FDG (fluorodeoxyglucose) dose (mean 9.5) and blood glucose levels (179.2). The table also presented the standard deviation, with corresponding ranges, reflecting variability within the studied group.

(Table 1) In this study represent the Correlation between FDG dose and Brain SUV, the table showed that there is significant correlation between FDG dose and Brain SUV with P value.001 ($p < 0.05$), means that FDG_dose_start has a positive effect on Brain_SUV. this result is disagree with (Sprinz1, 2, et. al 2018) his study showed that the brain was the only organ that presented a significant inverse relationship between SUVmax and glycemia ($p < 0.001$), even after controlling for diabetic status. No such difference was observed for the liver or lung

(Table 2) showed that there is significant correlation between FDG measured dose in the beginning of the procedure and the real injecting FDG dose with P value.000 ($p < 0.05$).

(Table 3) showed the correlation between the variables Glucose level, FDG dose and Heart SUV the analysis from this table showed that is significant correlation between Glucose level and heart SUV with (Pvalue.037) ($p < 0.05$), and also there is significant correlation between FDG dose start and Heart SUV (P value 0.13) ($p < 0.05$). This suggests higher glucose levels and FDG doses lead to lower heart SUV, Although the Previous study of (Henriksen et. al 2020) Increasing blood glucose and bodyweight are associated with increased image noise in standard imaging conditions

(Table 4) Represent the Correlation Between three variables Weight, Age, and Liver SUV, the result from this table showed that there is a significant correlation between patient wight and liver SUV (P value.016) ($p < 0.05$), meaning weight has a significant effect on Liver SUV, also showed that there is significant correlation between weight, age and Liver SUV (Pvalue.007) ($p < 0.05$) meaning that Both factors positively impact liver SUV.

(**Table 5)** Correlation Between Glucose Level and Spleen SUV the results indicate that there is significant correlation between glucose level and spleen SUV (p value .032) ($p < 0.05$) Higher glucose levels are associated with lower spleen SUV, the previous study of (Sarikaya et al 2019) showed that Hyperglycemia gradually reduces brain
18F - FDG uptake

(Table 6) Correlation Between Age, Height, and Brain SUV, the The results indicate that there is a significant correlation between Age and brain SUV (pvalue.002) ($p < 0.05$)

Also the table showed there is a significant correlation between Age, height and brain SUV (p value.000) ($p < 0.05$), (ZAHARI, et al 2022) showed in his study. The parameters were statistically correlated with clinicopathological factors including patients' age, body mass index (BMI) and tumour size. Multivariate regression was performed to determine the significant factors that best predicted those metabolic parameters

(Table 7) Correlation Between FDG Dose, Body Mass Index (BMI), and Liver SUV

The results showed that there is a significant correlation between the FDG dose and Liver SUV (p value.011) ($p < 0.05$), also there is significant correlation between FDG dose, body mass index and Liver SUV (Pvalue.002) ($p < 0.05$) both of these factors has effect on Liver SUV. correlation of BG with brain uptake, an author study near this result (Batallés et. al 2012) Hepatic uptake of 18FFDG increases according to the patient's BMI. The independent variables that best predict the hepatic SUV value are age and sex of patients. Our findings show that the practice of using the physiological hepatic metabolic activity level as a reference regarding questionable deposits elsewhere in the abdomen and pelvis is not useful, at least in male patients with overweightness and obesity.

5. Conclusion

FDG dose significantly affects SUV values in various organs. Brain SUV increases with FDG dose. Heart and liver SUV decrease with increasing FDG dose. Glucose levels negatively impact SUV in the heart and spleen. Suggests an inverse relationship between glucose metabolism and FDG uptake in these regions. Physical factors (age, height, weight, BMI) play a role in SUV variations. Older individuals have lower brain SUV. Higher weight and BMI correlate with higher SUV in the liver.

Disclosure
No potential conflict of interest relevant to this article was reported.

References

[1] Sprinz C, Zanon M, Altmayer S, Watte G, Irion K, Marchiori E, Hochhegger B. Effects of blood glucose level on 18F fluorodeoxyglucose (18F - FDG) uptake for PET/CT in normal organs: an analysis on 5623 patients. Scientific reports.2018 Feb 1; 8 (1): 2126.

[2] Sprinz C, Altmayer S, Zanon M, Watte G, Irion K, Marchiori E, Hochhegger B. Effects of blood glucose level on 18F - FDG uptake for PET/CT in normal organs: a systematic review. PloS one.2018 Feb 27; 13 (2): e0193140.

[3] Eskian M, Alavi A, Khorasanizadeh M, Viglianti BL, Jacobsson H, Barwick TD, Meysamie A, Yi SK, Iwano S, Bybel B, Caobelli F. Effect of blood glucose level on standardized uptake value (SUV) in 18 F - FDG PET - scan: a systematic review and meta - analysis of 20, 807 individual SUV measurements. European journal of nuclear medicine and molecular imaging.2019 Jan; 46: 224 - 37.

[4] Cengiz A. The Relation Between the Blood Glucose Level and the FDG Uptake of Tissues at Normal or Near - Normal PET/CT Imaging. Akdeniz Tıp Dergisi.2019; 5 (2): 365 - 9.

[5] Bucerius J, Mani V, Moncrieff C, Machac J, Fuster V, Farkouh ME, Tawakol A, Rudd JH, Fayad ZA. Optimizing 18 F - FDG PET/CT imaging of vessel wall inflammation: the impact of 18 F - FDG circulation time, injected dose, uptake parameters, and fasting blood glucose levels. European journal of nuclear medicine and molecular imaging.2014 Feb; 41: 369 - 83.

[6] Abd - Elkader MS, Elmaghraby SM, Abdel - Mohsen MA, Khalil MM. Estimation of liver standardized uptake value in F18 - FDG PET/CT scanning: impact of different malignancies, blood glucose level, body weight normalization, and imaging systems. Annals of Nuclear Medicine.2024 Oct 16: 1 - 3.

[7] Hu L, Qiu C, Wang X, Xu M, Shao X, Wang Y. The association between diabetes mellitus and reduction in myocardial glucose uptake: a population - based 18 F - FDG PET/CT study. BMC Cardiovascular Disorders.2018 Dec; 18: 1 - 8.

[8] Sarikaya I, Sarikaya A, Sharma P. Assessing the effect of various blood glucose levels on 18F - FDG activity in the brain, liver, and blood pool. Journal of Nuclear Medicine Technology.2019 Dec 1; 47 (4): 313 - 8.

[9] Mostafa R, Askar HA, Helbawi MN, Mahmoud HA. Association of Normal Organs Standardized Uptake Values with Serum Blood Glucose in F - 18 Fluorodeoxyglucose Positron Emission Tomography/Computed Tomography. Egyptian Journal Nuclear Medicine.2024 Jun 1; 28 (1): 56 - 64.

[10] Surasi DS, Bhambhvani P, Baldwin JA, Almodovar SE, O'Malley JP.18F - FDG PET and PET/CT patient preparation: a review of the literature. Journal of nuclear medicine technology.2014 Mar 1; 42 (1): 5 - 13.

[11] Fowler AM, Kumar M, Bancroft LH, Salem K, Johnson JM, Karow J, Perlman SB, Bradshaw TJ, Hurley SA, McMillan AB, Strigel RM. Measuring glucose uptake in primary invasive breast cancer using simultaneous time - of - flight breast PET/MRI: a method comparison study with prone PET/CT. Radiology: Imaging Cancer.2021 Jan 15; 3 (1): e200091.

[12] Lu W, Duan Y, Li K, Qiu J, Cheng Z. Glucose uptake and distribution across the human skeleton using state - of - the - art total - body PET/CT. Bone Research.2023 Jul 6; 11 (1): 36.

[13] Henriksen OM, Holm S, Marner L, Law I. Effect of blood glucose and body weight on image quality in

brain [18F] FDG PET imaging. Nuclear Medicine Communications.2020 Dec 1; 41 (12): 1265 - 74.
[14] Pahk K, Kim EJ, Lee YJ, Kim S, Seo HS. Characterization of glucose uptake metabolism in visceral fat by 18 F - FDG PET/CT reflects inflammatory status in metabolic syndrome. PLoS One.2020 Feb 6; 15 (2): e0228602.
[15] Pahk K, Kim EJ, Joung C, Seo HS, Kim S. Association of glucose uptake of visceral fat and acute myocardial infarction: a pilot 18 F - FDG PET/CT study. Cardiovascular Diabetology.2020 Dec; 19: 1 - 1.
[16] Lee Y, Jang J, Lim S, Na SJ. Evaluation of clinical variables affecting myocardial glucose uptake in cardiac FDG PET. Diagnostics.2024 Aug 6; 14 (16): 1705.
[17] Thientunyakit T, Wongsurawat N, Hannanthawiwat C, Nimmannit A. Relationship between Fasting Blood Glucose Level and 18F - FDG PET/CT Biodistribution Quality in Patients with Cancer: How Much Should We Concern? Journal of the Medical Association of Thailand.2017 May 1; 100 (5).
[18] Mahmud MH, Nordin AJ, Saad FF, Azman AZ. Impacts of biological and procedural factors on semiquantification uptake value of liver in fluorine - 18 fluorodeoxyglucose positron emission tomography/ computed tomography imaging. Quantitative imaging in medicine and surgery.2015 Oct; 5 (5): 700.
[19] Sarikaya I, Albatineh AN, Sarikayaa A. Effect of various blood glucose levels on regional FDG uptake in the brain. Asia Oceania Journal of Nuclear Medicine and Biology.2020; 8 (1): 46.