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*Research article*

# Association of the echocardiographic parameters with the physical dimension of quality of life

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**Abstract:** Heart failure (HF) is determined by pathophysiologic changes in the left ventricle (LV) that occur before the onset of clinical symptoms; these changes can lead to mitral insufficiency that will maintain and favor ventricular dysfunction. An associated change in contractility occurs which will maintain the vicious circle. 252 patients with HF were included in this cross-sectional analysis. Patients were divided into two groups, Group I-S/V (n = 55) and Group II-CT (n = 197) to comparatively assess cardi-ac parameters according to the administered therapy and to determine their correlation with quality of life domains. 2D measurements were performed to determine ultrasound parameters. The WHOQOL-BREF questionnaire was used to assess the quality of life. When analyzing the mean values of the determined echocardiographic parame-ters, significant differences in LV ejection fraction (LVEF) ($p < 0.03$) Results: Analysing the mean values of the echocardiographic parameters determined, significant differences in LV ejection fraction (LV ejection fraction (LVEF) ($p < 0.001$) and right ventricular diameter ($p = 0.030$) were found between the two study groups. The incidence of aortic regurgitation and tricuspid regurgitation was higher in the I-S/V group (40% vs. 25%, $p = 0.001$, respec-tively 47% vs. 35%, $p = 0.03$). Mitral regurgitation was present in relatively similar per-centages. Testing the association of echocardiographic parameters with quality of life do-mains showed a significant association of LVEF with physical health and relationship with the environment ($p = 0.002$, $r = 0.143$, respectively $p = 0.041$, $r = 0.129$). Physical dimension and relationship with the environment are more affected in pa-tients with low LVEF. Routine echocardiographic evaluation is essential in the global as-sessment of the HF patient and may suggest a low quality of life with impaired physical dimension.

**Keywords:** echocardiographic parameters, quality of life, physical health, descriptive analysis, WHOQOL-BREF score

## 1. Introduction

Heart failure (HF), clinically characterized by dyspnea, fatigue, and other major and minor symptoms, (1) is the end stage of many heart diseases. It is determined by pathophysiologic changes in the left ventricle (LV) that occur before the onset of clinical symptoms. In HF, from a morphopathologic point of view, LV dilatation or hypertrophy occurs, followed by spherical remodelling of the ventricle. This remodelling can lead to mitral insufficiency, which will maintain and favour ventricular dysfunction. An associated change in contractility occurs, which will keep the vicious circle (2).

HF is a public health problem due to the high costs of patient care and increased mortality and morbidity. For this reason, current guidelines emphasise the importance of combining cardiac ultrasound with clinical examination. The role of imaging is to assess the systolic and diastolic function of the LV, right ventricle (RV), right atrium (RA), left atrium (LA) (3), LV volume and cardiac output, along with the dimensions of the ventricular and interseptal walls and their contractile activity (4).

Determined hemodynamic parameters are crucial for identifying decompensated forms, implementing treatment, and making a preclinical diagnosis.

An essential parameter obtained by echocardiography is LVEF, which defines the type of HF; besides LVEF, left atrial and right ventricular function (a prognostic factor) can be determined and used prognostic factors. It can also refute the diagnosis of HFpEF in patients with dyspnea of another cause (5). An article published in 2020 by G. La Canna and I. Scarfo highlights the importance of assessing myocardial contractility and myocardial deformation indices by the echocardiographic method (3D analysis, 2D/3D Speckle Tracking). These special techniques for identifying contractility may allow a differential diagnosis of hypertrophy and analyze the motion in different areas of the myocardium (apical or mid-basal) (4).

Therefore, echocardiography is a versatile, low-cost technique, which, by evaluating the mentioned parameters, can indicate HF in the preclinical phase and has the role of assessing the results of the implemented therapy (2). Clinical evaluation is completed by hemodynamic tests, cardiac MRI and genetic analysis (6).

Our investigation aimed to assess cardiac parameters according to the therapy administered comparatively and to identify the correlation of status of tho parameters with the domains of quality of life (physical health, psychological health, social and environmental relationships).

## 2. Results

### 2.1. *Demographic and clinically relevant characteristics*

The study groups were relatively homogeneous regarding mean patient age (63.46 ± 11.50 vs. 66.327 ± 11.24, $p = 0.103$), with a mean cohort age of 64.91 ± 11.49. In both groups, male sex predominated (more than 50% of recruited patients). Most patients were from urban areas (71.07% vs. 54.55%). From the analysis of the obtained data, significant differences in the frequency of HF (stage I and II, $p < 0.0001$), frequency of high blood pressure (BPH) and dilated cardiomyopathy ($p < 0.001$) were found.

When analysing the mean values of the determined echocardiographic parameters, significant differences in LVEF ($p < 0.001$) and RV diameter ($p = 0.030$) were recorded between the two study groups (Table 1). Domains assessed the mean values of the quality of life scores, and significant differences between groups were recorded, except for the social relationship domain. The results are presented in Table 1; the overall distribution, individual trend, median, quartiles and outliers for parameters with significant differences between the two groups are shown in Figure 1.

**Table 1.** Descriptive analysis of clinical parameters.

| Parameter | Group | Mean ± SD | Minimum | Maximum | p-value |
|---|---|---|---|---|---|
| **Echocardiographic parameters** | | | | | |
| RV | II-CT | 2.767 ± 0.835 | 1.900 | 12.900 | 0.030** |
| | I-S/V | 2.898 ± 0.522 | 2.100 | 4.300 | |
| IVSd | II-CT | 1.259 ± 0.186 | 0.800 | 2.100 | 0.500* |
| | I-S/V | 1.240 ± 0.149 | 0.900 | 1.600 | |
| LVPWd | II-CT | 1.164 ± 0.146 | 0.800 | 1.800 | 0.312* |
| | I-S/V | 1.187 ± 0.138 | 0.900 | 1.600 | |
| LA | II-CT | 4.132 ± 0.697 | 2.300 | 6.200 | 0.456* |
| | I-S/V | 4.308 ± 0.870 | 3.000 | 7.000 | |
| LVEF | II-CT | 0.513 ± 0.073 | 0.210 | 0.640 | < 0.001** |
| | I-S/V | 0.454 ± 0.104 | 0.025 | 0.640 | |
| AA | II-CT | 2.269 ± 0.239 | 1.800 | 3.400 | 0.107* |
| | I-S/V | 2.195 ± 0.263 | 1.600 | 2.800 | |
| **Quality of life domains** | | | | | |
| Physical health | II-CT | 61.909±19.855 | 19.000 | 94.000 | 0.003** |
| | I-S/V | 52.545 ± 22.623 | 25.000 | 88.000 | |
| Psychological | II-CT | 66.310 ± 17.594 | 13.000 | 88.000 | 0.037* |
| | I-S/V | 60.764 ± 16.349 | 38.000 | 81.000 | |
| Social relationships | II-CT | 65.401 ± 13.324 | 19.000 | 94.000 | 0.069* |
| | I-S/V | 61.764 ± 12.038 | 25.000 | 81.000 | |
| Environment | II-CT | 61.157 ± 13.934 | 25.000 | 81.000 | < 0.001** |
| | I-S/V | 53.036 ± 16.186 | 31.000 | 69.000 | |
| Score WHOQOL-BREF | II-CT | 63.694 ± 16.176 | 19.000 | 90.000 | 0.007 |
| | I- S/V | 57.027 ± 16.799 | 30.000 | 64.000 | |
| Physical health | T | 59.865 ± 20.808 | 19.000 | 94.000 | - |
| Psychological | T | 65.099 ± 17.450 | 13.000 | 88.000 | - |
| Social relationships | T | 64.607 ± 13.117 | 19.000 | 94.000 | - |
| Environment | total | 59.385 ± 14.808 | 25.000 | 81.000 | - |

Group T − Total Group; Group I-S/V − patients undergoing treatment with sacubitril/valsartan; Group II-CT − patients receiving conventional therapy; p* − student test; p** − Mann- Whitney; SD − Standard Deviation; IVSd − interventricular septum diameter; LVPWd − left ventricular posterior wall diameter; LA − left atrial diameter; RTDLV − LV telediastolic diameter; LVEF − LV ejection fraction; RV − Right ventricle; RA − Right atrium ; AA − Aorta at the annulus.

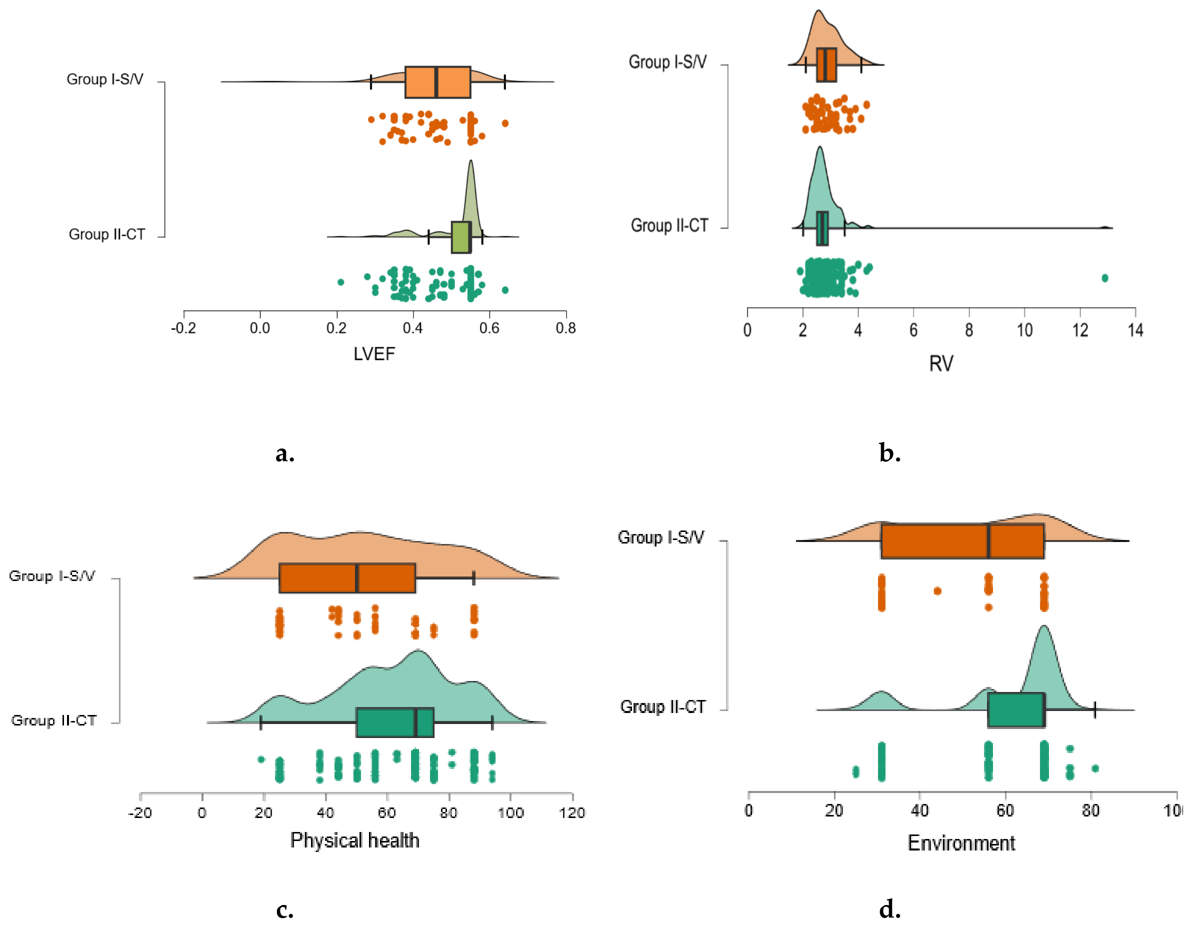



**Figure 1.** Distribution of parameters with significant differences according to group: **a.** LVEF – left ventricular ejection fraction; **b.** RV – right ventricle; **c.** WHOQOL-BREF score related to physical health; **d.** WHOQOL-BREF score related to environment.

In accordance with the medication followed, Table 2 suggests that the majority of Group I-S/V patients are treated with S/V at a dose of 24/26 mg bi-daily. A percentage of 12.73% of the same group also associated a SGLT2 inhibitor vs. 3.55% of Group II-CT.

**Table 2**. Distribution according to medication.

| Medication and doses | CT | CT + SGLT2 | S/V - 24/26 mg BD + SGLT2 | S/V - 24/26 mg BD | S/V - 49/51 mg BD | S/V -97/103 mg BD |
|---|---|---|---|---|---|---|
| N (%) | 190 (96.45) | 7 (3.55) | 7 (12.73) | 39 (70.90) | 5 (9.09) | 4 (7.27) |

BD – bi-daily.

### 2.2. *Overview of the valve apparatus*

The incidence of Ao regurgitation and tricuspid regurgitation was higher in Group I-S/V (40% vs. 25%, p = 0.001, respectively 47% vs. 35%, p = 0.03). Mitral regurgitation (Table 3) is present in relatively similar percentages (91.3% in Group II-CT vs. 81.81% in Group I-S/V, p = 0.44).

**Table 3.** Distribution of mitral, aortic and tricuspid regurgitation according to group.

| RM | Group II-CT | Group I-S/V | R AO | Group II-CT | Group I-S/V | R T | Group II-CT | Group I-S/V |
|---|---|---|---|---|---|---|---|---|
| NO (N) | 17 | 10 | NO (N) | 146 | 33 | NO (N) | 129 | 29 |
| RM I (N) | 62 | 23 | R AO I (N) | 29 | 15 | RT I (N) | 8 | 4 |
| RM II (N) | 20 | 6 | R AO II (N) | 8 | 2 | R TII (N) | 21 | 15 |
| RM III (N) | 5 | 4 | R AO III (N) | 1 | 0 | RT III (N) | 4 | 3 |
| RM MIN (N) | 91 | 12 | R AO MIN (N) | 12 | 2 | RT MIN (N) | 34 | 4 |

N − number of patients; RM − mitral regurgitation; R AO − aortic regurgitation; R − tricuspid regurgitation; Min − minor, I, II, III − stages of regurgitation.

### 2.3. *Correlation of echocardiographic parameters with quality of life domains*

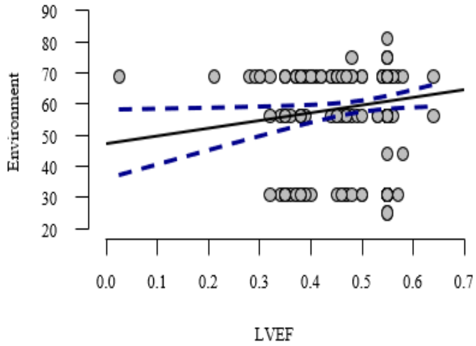
Tests of the association of echocardiographic parameters with quality of life domains (Table 4) showed a significant association only for left ventricular ejection fraction with physical health and relationship with the environment (p = 0.002, r = 0.143, p = 0.041, r = 0.138, respectively).

**Table 4.** Correlation of echocardiographic parameters with quality of life domains.

| Variable | | Physical health | Psychological | Social relationships | Environment |
|---|---|---|---|---|---|
| IVSd | Pearson's r | 0.059 | 0.031 | 0.031 | 0.024 |
| | p-value | 0.358 | 0.626 | 0.631 | 0.712 |
| LVPWd | Pearson's r | 0.029 | 0.015 | 0.016 | -0.012 |
| | p-value | 0.650 | 0.816 | 0.806 | 0.854 |
| LV | Pearson's r | -0.118 | -0.125 | -0.078 | -0.142 |
| | p-value | 0.063 | 0.059 | 0.219 | 0.025 |
| AA | Pearson's r | -0.095 | -0.123 | -0.090 | -0.087 |
| | p-value | 0.133 | 0.053 | 0.159 | 0.171 |
| LA | Pearson's r | -0.083 | -0.098 | -0.100 | -0.086 |
| | p-value | 0.193 | 0.123 | 0.115 | 0.174 |
| RV | Pearson's r | -0.028 | -0.021 | 0.008 | -0.022 |
| | p-value | 0.660 | 0.745 | 0.905 | 0.734 |
| LVEF | Pearson's r | 0.143 | 0.097 | 0.050 | 0.129 |
| | p-value | 0.002 | 0.124 | 0.427 | 0.041 |

IVSd − interventricular septum diameter; LVPWd − left ventricular posterior wall diameter; LA − left atrial diameter; LVEF − LV ejection fraction; RV − Right ventricle; RA − Right atrium; AA − Aorta at annulus.

The significant positive association between LVEF with physical health and the relationship with the environment indicates that as the ejection fraction increases, the quality of life also increases (Figure 2a and 2b).




**a.** **b.**

**Figure 2. a.** Linking LVEF with Physical Health; **b.** Linking LVEF with Environment.

## 3. Discussion

HF is a chronic disease that affects patients' quality of life, both at the somatic (physical) level and in terms of social and environmental relationships, implicitly affecting psychological well-being (7). Several questionnaires have been identified in the literature for assessing the quality of life (Minnesota Living with Heart Failure, Kansas City Cardiomyopathy Questionnaire and WHOQoL-BREF). In this study, the short form of the WHOQoL was chosen because it is simple to administer and assesses the four important domains of quality of life. The survey by I.H. Kraai et al. (2014) showed that most patients attach greater importance to the quality of life than the length of life (8).

Several factors have been shown to influence quality of life (9). The aim of this study was to assess cardiac parameters according to the therapy administered comparatively and to determine their association with quality of life assessed in 4 domains: physical, psychological, social and environmental.

For a long time, specialised studies have been focused on determining LVEF. Nowadays, increasing importance is being given to the dimension of LA, as its mechanical and neurohormonal properties are known, as well as the role of LA in the evolution towards HF of different pathologies. LA has a prognostic role, being a predictor of increased mortality.

Maximal LA elongation correlates with exercise functional capacity, affecting patients with dilated cardiomyopathy (10). The mean values obtained from the ultrasonographic measurements performed show that the left atrial dimension is increased in both groups (4.132 ± 0.697 vs. 4.308 ± 0.870), without statistically significant differences, but with a higher mean in the I -S/V group, explained by the higher incidence of DCM.

Data analysis showed that mitral regurgitation was present in the majority of patients included in the study, regardless of group (91.3% and 81.81%, respectively). This may explain the impairment of physical size in patients with HF, as mitral regurgitation is the main echocardiographic predictor of exercise capacity in patients with HF (11).

Statistical analysis suggests significant differences in mean values of LVEF (45.5 ± 0.4% vs. 51.3 ± 7.3%, $p < 0.001$) and VD (2.898 ± 0.522 vs. 2.767 ± 0.835) between the two study groups.

In our study, a correlation was identified with two domains of quality of life (somatic and relationship with the environment); a decrease in LVEF leads to a reduction in the score on the physical domain and the score for the relationship with the environment.

The study conducted by M. Kałużna-Oleksy on 152 patients with HF (2021) identifies a correlation between LVEF and quality of life in the physical domain (9). Despite contradictory results published in other studies. Patients with HFpEF have been identified who scored lower on self-assessment than patients with low EF (12).

The study of 758 patients (2021) suggests a significant association of LVEF with physical size in patients with stage III HF and no such association in NYHA stages I and II. It also supports an association of LV diastolic function with mental health (13).

Another study (2016) claims that LVEF has the greatest impact on patients' quality of life, regardless of the treatment followed (N=160 patients) (14).

Statistical analysis of the obtained data does not show a correlation with the quality of life domains of the other measured echocardiographic parameters.

Modern echocardiographic assessment allows comprehensive assessment of RV, both structural and functional. Studies emphasize the importance of RV assessment as an unfavorable prognostic factor when affected. To date, there is no specific treatment targeting DV. Conventional therapy (group I) and S/V (group II) are used in patients with HFrEF (15).

Statistical analysis of the RV ultrasonographic determinations shows that the mean values for both study groups are within the average values considered as reference (2.5-2.9 cm). In our study, the size determined for RV does not correlate with any dimension of quality of life.

The study performed in 70 patients with low EF (<40%), to whom the 6-minute walk test (6MWT) was applied, suggested the correlation of the dimension of the RV with the functional status of the patients (16).

### *3.1. Strengths and Limitations of the study*

Our study, which is one of the few in Romania to address the association between echocardiographic parameters and quality of life in patients with HF, provides important data for clinicians. It underscores the need for an individualized approach to patients with HF to improve their quality of life. However, it's important to note that these findings may not be universally applicable to the Romanian population due to the different sampling criteria. Therefore, further research is needed on a more homogeneous and larger cohort in line with the current phenotypic classification. This will help to better understand the implications of our findings for the Romanian population.

We consider the heterogeneity of the patients included in the study (being recruited patients with HFpEF and HFrEF) a limitation of the study.

Posibilitatea de variabilitate intre determinarile LVEF prin metoda Simpson, ar putea fi considerata o alta limitare; actual exista tehnici noi, speckle tracking echocardiography, cu o variabilitate intre determinari mai scazuta (17).

## 4. Materials and Methods

### *4.1. Participants and Methods*

This cross-sectional analysis included 252 patients with HF to assess cardiac parameters comparatively according to the therapy administered and to determine their correlation with quality of life domains. Patients with chronic HF, stage I, II, III New York Heart Association (NYHA) stage I, II, III, and stage IV NYHA and decompensated forms of associated diseases were included as exclusion criteria.

Two groups were formed based on therapy: Group I-S/V (n = 55) − patients undergoing treatment with sacubitril/valsartan, and Group II-CT (n = 197) − patients receiving conventional therapy (18).

### *4.2. Assessment methods*

Measurements, performed as recommended by the European Association of Cardiovascular Imaging (16) included the following parameters: interventricular septum diameter (IVSd, normal values: female − 0.6 - 0.9 cm, male − 0.6 - 1cm), left ventricular posterior wall diameter (LVPWd, normal values: female − 0.6-0.9 cm, male − 0.6 - 1cm), left atrial diameter (LA, normal values: female − 2.7 - 3.8 cm, male − 3- 4 cm), LV internal diastolic dimen-sion (LVIDd, normal values: female – 3.72 -5.22 cm, male – 4.2-5.84 cm), LV internal systolic dimension (LVISd normal values: female 2.16 - 3.48cm, male 2.5 -3.98 cm,) LV ejection fraction (LVEF, normal values: LVEF > 55%), right ventricle (RV, normal val-ues: 2.5 - 4.1 cm), right atrium (RA, normal values: 2.9 – 4.5 cm) and an overview of the aortic valvular apparatus (aortic annulus diameter, AA, normal values: 1.4 – 2.6 cm).

The 2D echocardiographic examinations and measurements were performed by a specialist cardiologist using the GE Ultrasound system Vivid E95 (GE Vigmed Ultrasound AS, Norway). LVEF was calculated by the biplane disc summation method (using the modified Simpson biplane method) on the two-dimensional echocardiographic images from the four- and two-chamber apical views according to the recommendations of the American Society of Echocardiography (17).

The short form of the World Health Organization WHOQOL-BREF questionnaire (License ID: 202300206) was used to determine the quality of life scores. This self-administered questionnaire consists of 26 items: the first two questions (Q1, Q2) refer to "individual's general perception of quality of life" and "individual's general perception of their health", and the following 24 items allow the assessment of four domains of quality of life, namely: physical health, psychological, social and environmental relations (7, 18, 19).

### *4.3. Ethical approval*

Ethics Committee' s Approval no. CEFMF/02/19.05.2022 was obtained from the Faculty of Medicine and Pharmacy, University of Oradea, Oradea, Romania, in accordance with the World Medical Association Declaration of Helsinki (20). Patients' participation was voluntary and they all signed an informed consent.

### *4.4. Statistical Analysis*

For the statistical analysis of the data, we used the JASP program version 0.18.3. (20) and parametric or non-parametric tests were used depending on the distribution of the determined parameters. Mean values, standard deviations, frequency ranges were determined. The statistical significance tests used were the Student's t-test and the Mann-Whitney U-test, depending on the dispersion's homogeneity; the statistical significance level was 0.05. Levene test was used to assess the homogeneity of dispersion. Chi-square test was used to test the relationship between categorical variables. Pearson correlation test was used to test the relationship between continuous variables.

## 5. Conclusions

Patients with low LVEF are more affected by physical size and relationship with the environment. Routine echocardiographic evaluation is essential in the global assessment of HF patients and may suggest a low quality of life. New national screening programs are needed to detect the early stages of HF and the control risk factors.

**Author Contributions:** Conceptualization, D.C.I., A.G.N., D.C.N.-C., and V.N.; methodology, S.G.B., D.M.T. and M.I.P; software, D.C.I., D.C.N-C. and D.M.T.; validation, A.C.N., S.G.B. and M.I.P; formal analysis, D.C.I., A.G.N., D.C.N.-C., and V.N.; investigation, D.C.I., A.G.N., D.C.N.-C., and V.N.; resources, D.C.I., D.C.N-C. and D.M.T.; data curation, D.C.I., A.G.N., D.C.N.-C., and V.N.; writing—original draft preparation, D.C.I., A.G.N., D.C.N-C. and D.M.T; writing—review and editing, S.G.B. and M.I.P.; visualization, all the authors; supervision, S.G.B. and M.I.P.; project administration, D.C.I. All authors have read and agreed to the published version of the manuscript.

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**Institutional Review Board Statement:** The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of the Facylty of Medicine and Parmacy, University of Oradea (CEFMF/02/19.05.2022), Oradea, Romania.

**Informed Consent Statement:** Informed consent was obtained from all subjects involved in the study.

**Data Availability Statement:** The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy reasons.

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**Conflicts of Interest:** The authors declare no conflict of interest.

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