BALNEO RESEARCH Balneo and PRM Research Journal
English Edition
e ISSN 2734 - 8458 p ISSN 2734 - 844X ROMANIAN ASSOCIATION OF BALNEOLOGY

Research article

The impact of the COVID-19 pandemic on the cardiac rehabilitation in diabetic patients with cardiovascular comorbidities admitted in a hospital from Transylvania

Mircea Vasile Milaciu[1], Andreea-Cezara Gerdanovics[1], Mirela-Georgiana Perné[1], Teodora-Gabriela Alexescu[1,*], George Ciulei [1], Angela Cozma [1], Olga-Hilda Orășan [1], Călin Vasile Vlad [1], Nicoleta-Valentina Leach [2] and Lorena Ciumărnean [2]

1 Department 4 - Internal Medicine, Faculty of Medicine, "Iuliu Haţieganu" University of Medicine and Pharmacy, Cluj-Napoca, Romania
2 Department 2, Faculty of Nursing and Health Sciences, "Iuliu Haţieganu" University of Medicine and Pharmacy, Cluj-Napoca, Romania

* Correspondence: teodora.alexescu@gmail.com

Citation: Milaciu M.V., Gerdanovics A.C., Perné M.G., Alexescu T.G., Ciulei G., Cozma A., Orășan O.H.1, Vlad C.V., Leach N.V., Ciumărnean L. - The impact of the COVID-19 pandemic on the cardiac rehabilitation in diabetic patients with cardiovascular comorbidities admitted in a hospital from Transylvania
Balneo and PRM Research Journal ***2025****, 16(3): 850*

Academic Editor(s):
Constantin Munteanu

Reviewer Officer:
Viorela Bembea

Production Officer:
Camil Filimon

Received: 09.08.2025
Published: 30.09.2025

Reviewers:
Sudheer Parihar
Andreea Vladulescu - Trandafir

Publisher's Note: Balneo and PRM Research Journal stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

Abstract: Diabetes Mellitus represents a global health issue with a greater risk of cardiovascular disease than non-diabetic individuals. Cardiac rehabilitation (CR) is a comprehensive program involving multiple disciplines that aims to enhance the well-being of individuals with cardiovascular conditions and it plays a vital role in preventing cardiovascular complications for patients diagnosed with Type 2 Diabetes Mellitus (T2DM). However, during the COVID-19 pandemic, the implementation of rehabilitation programs was also affected by decreased availability of on-site services. The main objective of this study was to evaluate the patterns of T2DM patients with cardiovascular comorbidities (particularly arterial hypertension) who were admitted to the Internal Medicine Section of the CF Clinical Hospital during the year before the COVID-19 pandemic (2018) and the pandemic year of 2021. In these patients, we have also identified the trends and pitfalls in the implementation of CR. The study was conducted in Romania, within the CF Clinical Hospital (Internal Medicine section), from the main city of Transylvania (Cluj-Napoca). A database was created of patients who were admitted to this hospital during a year before the COVID-19 pandemic (2018) and, respectively, during the pandemic year of 2021. Computer randomization was used to select 5 adult patients with T2DM, discharged each month from the selected years, thus forming 2 databases of 60 patients each (equal number of women n=31). We analyzed the differences in patterns of severity of the cardiovascular comorbidities and T2DM control, and also the different patterns of applying of CR. There were no statistically significant differences in the age of the patients, BMI, and waist circumference, although the median values for these parameters were higher in the pandemic group. However, there were significantly more diabetic patients with hypertension during the pandemic year (p=0.03), with higher severity and poorer control of their hypertension (p=0.003). Additionally, the 2021 cohort had a higher number of diabetic patients with poorly controlled disease (p=0.02), nearly doubling the number of patients requiring insulin treatment compared to the 2018 cohort. Metabolic syndrome was also significantly more prevalent in the 2021 study group compared to the 2018 study group (p=0.008). The COVID-19 pandemic significantly exacerbated the clinical presentation of diabetic patients admitted to the CF Clinical Hospital in Cluj-Napoca, Romania. There was a notable increase in admissions during the pandemic year of 2021 among individuals presenting with hypertension and diabetes mellitus, often characterized by advanced stages of disease severity. This clinical situation did not have a detrimental effect on CR programs, which were better implemented in patients with T2DM.

Keywords: rehabilitation programs, cancer, personalized physical rehabilitation

1. Introduction

Diabetes Mellitus (DM) is a global health issue and The International Diabetes Federation (IDF) predicts that the number of individuals with DM will increase from 10.7 million in 2019 to 13.7 million by 2030 [1]. Diabetic patients are known to have a risk of cardiovascular disease that is 2 to 4 times greater than the cardiovascular risk of non-diabetic individuals [2]. The most prevalent form of DM, the Type 2 Diabetes Mellitus (T2DM), is linked to various vascular complications, including coronary heart disease, cardiomyopathy, arrhythmias, sudden death, cerebrovascular disease, and peripheral artery disease. Among these complications, cardiovascular disease (primarily with atherosclerosis substrate) is the leading cause of mortality in individuals with DM. Numerous clinical studies have established a correlation between T2DM and vascular disease. However, it is important to note that diabetic patients often present with additional cardiovascular risk factors such as hypertension, obesity, and dyslipidemia [3]. More than half of individuals diagnosed with DM, whether type 1 or type 2, eventually develop hypertension as a commorbidity. This elevated blood pressure significantly increases the risk of cardiovascular disease (CVD) by two to three times and accelerates the progression of diabetic nephropathy [4].

Since the declaration of the coronavirus disease 2019 (COVID-19) pandemic, more than 5 years ago, a widespread devastation occurred in the healthcare systems worldwide. The onset of the COVID-19 pandemic has highlighted the interactions between T2DM and hypertension, raising increased concerns about the management and outcomes of hypertensive diabetic patients [5]. A review published in 2023 revealed that DM is a significant risk factor associated with worse outcomes and increased mortality in COVID-19 patients [6]. Other several studies have also reported a higher risk of death in patients with both T2DM and hypertension [7, 8, 9].

Preventing cardiovascular complications in diabetic patients successfully relies on the efficient cooperation among experts from various fields, such as cardiology, endocrinology, vascular surgery, radiology, physical medicine and rehabilitation, nutrition, podiatry, and others [1,10]. Cardiac rehabilitation (CR) is a comprehensive program involving multiple disciplines that aims to enhance the well-being of individuals with cardiovascular conditions and it plays a vital role in the treatment of patients diagnosed with type 2 diabetes mellitus (T2DM) who presents an increased risk of experiencing severe complications and a higher mortality rate due to COVID-19 [11]. Structured rehabilitation programs aid in restoring patients functional capacity, enhancing their quality of life, enabling optimal reintegration into daily activities, and reducing the risk of subsequent cardiovascular events or hospitalizations. The components of a cardiovascular rehabilitation program include the implementation of guideline-directed medical therapies, psychological support or counseling, assistance with (early) return to work and reassessment of driving ability, as well as lifestyle measures such as smoking cessation, dietary adjustments, and physical activity [12].

Cardiovascular rehabilitation therapy consists of three phases. Phase I occurs while the patient is still admitted to the hospital. Phase II takes place on an outpatient basis after the patient has been discharged. Phase III is a stand alone cardiovascular rehabilitation program that can be completed at home or in a community setting, outside of a hospital or facility. The target population for these programs includes patients with known cardiovascular illness, those currently or previously treated for cardiovascular disease, and individuals with risk factors for cardiovascular disease, such as people suffering from T2DM [1, 13]. The treatment for most chronic diseases typically includes physical training to decelerate or reverse disease progression. During physical exercise, hormones like insulin and glucagon regulate glucose absorp-

tion, with the balance between insulin and other regulatory hormones varying according to the type, intensity, and duration of the exercise [14]. Regular physical exercise is strongly recommended based on substantial evidence. Numerous studies have shown that while regular physical training provides antioxidant protection, strenuous exercise can increase oxidative stress by activating the metabolism of lipids, proteins, and even genetic material [15].

The benefits of secondary prevention strategies for chronic diseases, including diabetes, which focus on lifestyle modification and risk factor management, are well established worldwide [16]. However, adherence to these lifestyle changes, particularly shifting from a sedentary to an active pattern, remains a significant challenge for patients [17, 18]. Although formal rehabilitation, whether in clinical centers or through home rehabilitation, offers numerous benefits such as improved physical health, quality of life, and glycemic control, it is important to note that these sessions can become monotonous and unattractive over time [14].

In this context, programs incorporating multimodal interventions such as physical exercise, nutritional changes, behavioral therapy, and cognitive approaches have shown promising results in the medium [19] and long term [20, 21]. To support behavioral changes toward a healthier lifestyle, recent technologies have been integrated to broaden the reach of new interventional approaches for patients with T2DM. Mobile text messaging interventions have been found to improve glycemic control [22, 23] and encourage more active behavior among these patients. Technology-assisted self-monitoring has proven to be beneficial, safe, and feasible for promoting positive lifestyle changes.

During the COVID-19 pandemic, the gap in CR care has widened further due to the decreased availability of on-site services. In this context, home-based cardiac rehabilitation (HBCR) has been increasingly promoted as a potential solution in the COVID-19 pandemic emphasizing social distancing and the need for caregiving strategies that reach patients outside the hospital. Data validating its effectiveness compared to center-based models in terms of patient outcomes have used inconsistent protocols and have mostly been limited to patient populations with relatively lower risk profiles. Consequently, many clinicians remain skeptical about the utility of HBCR, particularly for patients with higher cardiovascular disease (CVD) risks [24]. Given these, implementing rehabilitation programs was affected during the COVID-19 pandemic in the patients with T2DM.

In Romania, CR centers/facilities have grown in numbers (a 69.2% increase was observed in 2024 compared to 2017), but there it still exists an uneven distribution nationwide [25].

The main aim of this study was to examine two populations of patients with T2DM and cardiovascular comorbidities, particularly arterial hypertension, who were admitted to the Internal Medicine Section of the CF Clinical Hospital during the year before the COVID-19 pandemic (2018) and the pandemic year of 2021. The objectives were to evaluate if there were different patterns of comorbidities and to evaluate the cardiac rehabilitation (CR) implemented for these patients, to identify any pitfalls and trends in the implementation of CR during the pandemic.

2. Results

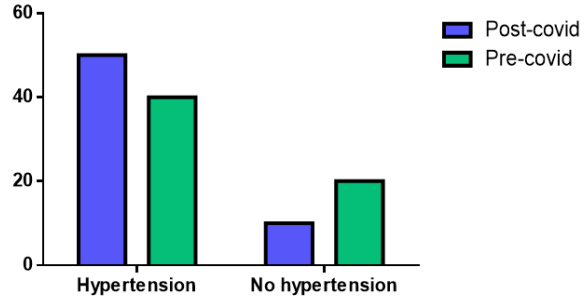
The information from the observation sheets was meticulously reviewed. We began by analyzing the distribution of patients by gender and age. As mentioned earlier, each of the two study groups consisted each of 29 male and 31 female patients. The female-to-male ratio slightly favored females because, overall, more women were admitted to the Internal Medicine Section during the study period. The demographic and clinical characteristics of both groups are presented in the following table (Table I).

Table I. Demographic characteristics of the study groups

Variables	Pre-pandemic (2018)	COVID-19 pandemic (2021)	P
Gender (Women)	31	31	-
Age (median)	63.5	67	0.14
Family history of CV diseases (no. of patients)	50	52	0.79
Smoking status (no. of patients)	32	33	0.95
Alcohol usage (no. of patients)	31	39	0.13
BMI (median; kg/m²)	30.02	30.28	0.53
Waist circumference (cm)	99 (+/- 15,15)	105	0.35
Hypertension (no. of patients)	40	50	0.03
Uncontrolled hypertension (no. of patients)	20	40	0.003
Coronary heart disease (no. of patients)	18	23	0.44
Uncontrolled T2DM (no. of patients)	19	31	0.02
Insulin used for T2DM (no. of patients)	10	19	0.05
Hypercholesterolemia (no. of patients)	38	43	0.32
Hypo-HDL cholesterolemia (no. of patients)	31	37	0.26
Hypertriglyceridemia (no. of patients)	36	43	0.17
Metabolic syndrome (no. of patients)	31	45	0.008

In the 2021 group, 26 subjects (43.33%) had been vaccinated for COVID-19 prior to hospital admission. The Mann-Whitney U Test indicated no significant differences in age distribution between the two groups, despite the median age being higher for the patients hospitalized during the pandemic. Regarding anthropometric parameters, we recorded the body mass index (BMI) and waist circumference of the patients, as obesity and especially abdominal obesity are direct components of metabolic syndrome and cardiovascular risk factors; the results showed that the 2021 group were slightly more obese than the pre-pandemic group. Another notable finding is that 83.33 % of patients in the pre-pandemic group reported a positive family history of cardiovascular conditions (such as hypertension, ischemic heart disease, cerebrovascular disease, and stroke). This percentage was even higher in the pandemic group, with 86.66% reporting a similar family history.

Since the primary focus of this study was the prevalence of cardiovascular comorbidities in the two patient cohorts, hypertension was meticulously evaluated. In the pre-pandemic cohort ("Pre-COVID"), 40 patients (66.66%) had hypertension. This prevalence increased to 83.33% (n=50) in the pandemic cohort from 2021 ("Post-COVID"). The significant diffe rence between the two groups was analyzed using the Chi-Square test, with the results summarized in Figure 1. When analyzing the degree of hypertension (measured on a standard scale from 1 to 3), there were more cases of severe hypertension in the pandemic cohort compared to the 2018 cohort. As summarized in Figure 2, the median degree of hypertension was 1.366 in the pre-pandemic group (blue) and 1.933 in the pandemic group (red).



Chi-square, Two-sided

Z = 2.108

P value = 0.0350 Odds ratio = 2.500

95% confidence interval: 1.052 to 5.942

Figure 1. Distribution of hypertension in the studied groups

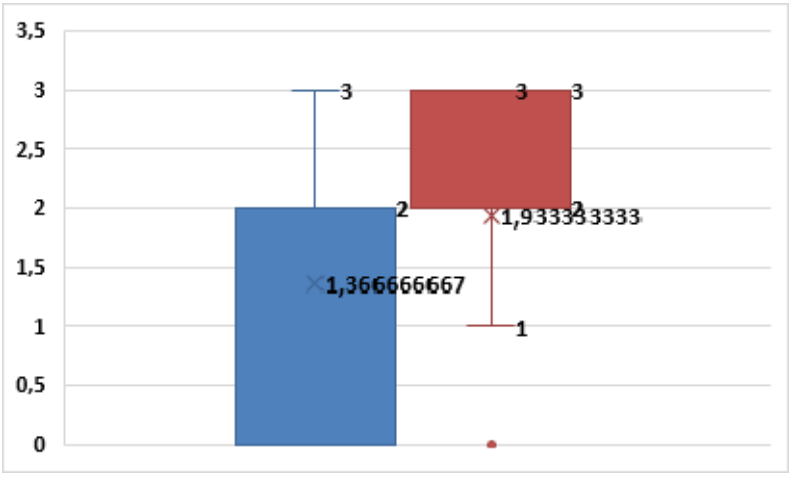
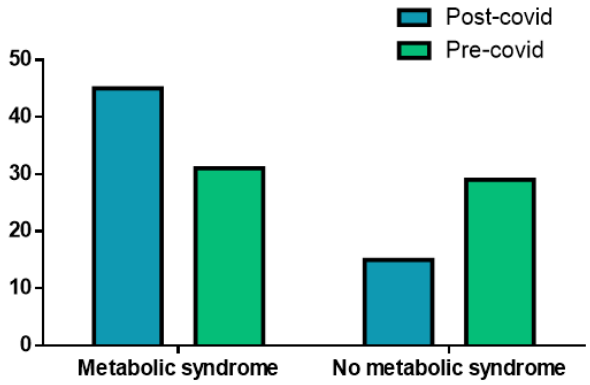


Figure 2. Distribution of hypertension according to the degree of hypertension (1 to 3) in the pre-pandemic 2018 cohort (blue) and pandemic 2021 cohort (red)

Every patient in this study had a confirmed diagnosis of T2DM at hospital discharge. The status of their diabetes was categorized as either "Controlled" or "Uncontrolled," based on their glycated hemoglobin (HbA1c) levels, with a threshold set at 7% A1c. Analysis revealed that the pandemic group had a significantly higher number of patients with uncontrolled diabetes compared to the 2018 group ($P < 0.05$).

The parameters monitored allowed us to determine whether patients had metabolic syndrome (MS). We evaluated the presence of MS in the study groups using the Chi-square test, which revealed a statistically significant higher prevalence of MS in the COVID-19 pandemic group (labeled as "Post-covid" in the following image - Figure 3).



Chi-square test, Two-sided

Z = 2.652

P value = 0.0080

Odds ratio = 2.806

95% confidence interval: 1.295 to 6.082

Figure 3. Distribution of patients regarding the presence of the MS (and comparison using the Chi-square test)

Documented practices of rehabilitation and late rehabilitation (health promotion after the finishing of the treatment) were recorded. We found that these important interventions were clearly underperformed in both evaluated timeframes (with the reserve that maybe some interventions were applied, but not mentioned written in the patient documents).

Among the assessed rehabilitation practices (Table II), a statistically significant increase during the COVID-19 pandemic period (2021) compared to the pre-pandemic period (2018) was observed only for completed nursing files (OR 0.33; 95% CI: 0.13–0.82; p = 0.02) and for rehabilitation indicated at discharge (OR 0.41; 95% CI: 0.20–0.86; p = 0.03). No significant differences were found for recorded rehabilitation interventions (OR 0.66; 95% CI: 0.33–1.39; p = 0.35), cardiac rehabilitation (OR 0.59; 95% CI: 0.25–1.40; p = 0.30), or home-based cardiac rehabilitation (OR 0.22; 95% CI: 0.04–1.00; p = 0.09), although a trend toward increased home-based interventions was noted.

Table II. Distribution of patients that received rehabilitation interventions

Variables	**Pre-pandemic (2018)**	**COVID-19 pandemic (2021)**	**OR[1] (95% CI[2])**	**P***
Completed nursing files	41	52	0.33 (0.13-0.82)	0.02
Recorded rehabilitation interventions	24	30	0.66 (0.33-1.39)	0.35
Cardiac rehabilitation	13	19	0.59 (0.25-1.40)	0.30
Home-based cardiac rehabilitation	2	8	0.22 (0.04-1.00)	0.09
Rehabilitation indicated at discharge	16	28	0.41 (0.20-0.86)	0.03
[1]OR – Odds Ratio, [2]CI – confidence interval				
*** *p* value < 0.05 considered as statistically significant**				

3. Discussion

Essential hypertension and T2DM are both highly prevalent conditions, so their coexistence is not unexpected. Since each condition individually increases the risk of coronary artery disease, cerebrovascular disease, renal failure, and heart failure, it is essential to manage both effectively to reduce these risks. [26]

The present study aimed to examine the clinical aspects of two cohorts of patients with T2DM, one from before the COVID-19 pandemic (2018) and one from during the pandemic (2021). The focus was on detailing the hypertension status in these patients, including its presence, control, severity, and the medications used.

We started by comparing the two cohorts, which were randomly constructed to minimize bias (with a similar male-to-female ratio in both groups). The average age in the 2018 cohort was 63.9 years, compared to 66.9 years in the 2021 cohort. This age difference was anticipated, given that older adults were more severely affected by the COVID-19 pandemic. It has been reported that individuals over 65 accounted for nearly 80% of COVID-19 hospitalizations and had over 23 times the risk of death compared to those under 65 [27].

Elderly individuals faced challenges beyond COVID-19 itself. Since the pandemic began in March 2020, preventive measures such as lockdowns, social isolation, quarantine, and social distancing were implemented to curb the virus's spread. While effective in reducing infection rates, these measures also led to increased social isolation and loneliness among older adults, negatively impacting their mental and physical health [28].

At the CF Clinical Hospital, which primarily treated infectious diseases rather than COVID-19 cases, it was noted that older adults were often reluctant to seek medical care promptly and frequently required ambulance transport due to deteriorated conditions at home. This hesitation was observed globally, with a noted decline in ambulance calls during the pandemic, which persisted until lockdown measures were eased [29]. It is evident that the pandemic's impact on the mental health of the elderly had detrimental effects on their hospital visit patterns [30].

In this study, neither obesity as defined by BMI nor abdominal obesity based on waist circumference showed statistically significant differences between the two cohorts, although they were more prevalent in the 2021 group. Research indicates that not only were obese individuals more susceptible to developing COVID-19, but those unaffected by the virus were also at increased risk of obesity due to pandemic-related restrictions and social isolation, exacerbating the obesity crisis [31].

A 2023 study identified various factors contributing to obesity risk during the COVID-19 lockdown, including age, socioeconomic status, physical inactivity, sedentary behavior, poor sleep quality, excessive technology use, substance abuse, unhealthy dietary habits, and psychological issues. These factors collectively increased the risk of obesity during the lockdown period [32].

Abdominal obesity, or central obesity, has been shown to have an even more detrimental impact during the COVID-19 pandemic, as it can further lower antibody titers following COVID-19 vaccination [33]. In this study, the median waist circumference was higher in the 2021 cohort, indicating that a greater number of patients with abdominal obesity were admitted during the pandemic.

Data from early 2020 in China and the United States revealed that hypertension was the most frequently observed comorbidity among hospitalized COVID-19 patients, with prevalence ranging from 30% to nearly 50%. Hypertensive individuals who contracted COVID-19 were more likely to require hospitalization than those without hypertension [34]. Current evidence indicates that hypertension is associated

with higher mortality risk, increased severity of COVID-19, and a greater likelihood of requiring intensive care [35].

The pandemic not only altered healthcare utilization but also shifted patterns of hospital admissions, with hypertension among the conditions studied. Hospitalizations for most primary diagnoses declined significantly in March 2020 [36]. However, admissions for reproductive neoplasms, hypertension, and diabetes returned to pre-pandemic levels by late 2020 and early 2021, while admissions for infectious respiratory diseases did not reach pre-pandemic levels during this period [37]. Other studies have noted higher mortality rates following hospitalization during the pandemic compared to pre-pandemic times [38].

A cohort study of 8,448,758 admissions across 4,626 U.S. hospitals from 2019 to 2021 found a significant drop in admissions for non-SARS-CoV-2 diagnoses in 2020, with lower levels persisting until September 2021. Mortality rates were notably higher after hospitalization, particularly among Black individuals, Hispanic individuals, and those with low socioeconomic status. The increase in mortality was more pronounced in lower-quality hospitals and those with high SARS-CoV-2 caseloads [38].

Additional research has shown that the COVID-19 pandemic adversely affected outcomes for patients admitted for non-COVID conditions. A study from Spain published in 2023 [39] reported that during the initial wave of the pandemic (February 27 to June 7, 2020), over 10,000 patients were hospitalized, with 3% having COVID-19 and 97% with non-COVID conditions. Compared to pre-pandemic years (2017-2019), non-COVID medical admissions decreased by 22% and surgical admissions by 33%. Moreover, there was a concerning 25.7% increase in hospital mortality among non-COVID patients during the first wave. This trend of increased mortality was also observed in other studies, possibly linked to the high volume of hospital admissions [40]. Non-COVID patients hospitalized during the first wave were generally older, more often male, had longer hospital stays, and presented with more severe conditions compared to those admitted before the pandemic [39].

Regarding metabolic syndrome components, reviews have found that hypertension had the strongest correlation with COVID-19 incidence, followed by obesity. Although the precise pathophysiological mechanisms remain unclear, they are likely related to cardiovascular complications. Diabetes is thought to exacerbate COVID-19 severity through chronic inflammation and its impact on neutrophil and T-cell function. Additionally, dyslipidemia might facilitate SARS-CoV-2 infection by enhancing lipid rafts and exerting immunosuppressive effects [41].

In this study, patients with T2DM from 2021 were more likely to have hypertension and exhibit all components of metabolic syndrome compared to those in the pre-pandemic year of 2018. Metabolic syndrome was more prevalent among COVID-19 patients and also increased during the pandemic year 2020, with an incidence of 18.6% compared to 15.7% before the epidemic. Post-lockdown, there was a notable rise in abnormal metabolic syndrome components compared to 2018.

After an extensive assessement of the patient´s files (nursing files, doctor´s prescriptions and discharge papers), we have observed that the cardiac rehabilitation (CR) was better implemented, applied and prescribed at home in the pandemic period vs the pre-pandemic timeline. While the main changes in prescribing CR after the COVID-19 pandemic were the expansion of home-based, virtual, and hybrid models, increased use of telehealth [42-44], we have observed that even during the hospital admission there was a better assessement and implementing of CR in the hospital setting.

Multiple studies and reviews have documented that, in response to the COVID-19 pandemic and the suspension or reduction of center-based programs, healthcare systems accelerated the use of technology-supported, home-based, and hybrid CR approaches. These adaptations enabled continued delivery of CR services, often with

similar short-term clinical outcomes, exercise capacity improvements, and patient adherence compared to traditional center-based models [42, 44, 45]. However, the literature also frequently highlights the contrary, that while implementation improved for some patient groups, access disparities persisted, and certain high-risk populations were less likely to be included in remote programs [46, 47].

In our study, the better CR implementing could partially be attributed to better regulations by the authorities during the COVID-19 pandemic, and, in this particular situation, to the urgent need of CR for the patients with T2DM with more and severe cardiovascular comorbidities than the patients from the 2018 cohort. To our knowledge, this is the first study from Romania to show that during the COVID-19 pandemic the implementation of CR in a university hospital improved. On the contrary, multiple studies consistently report that the pandemic and its associated restrictions led to significant disruptions in traditional, center-based CR services, with most programs experiencing suspension, reduced capacity, or a shift to home-based or telehealth models [47, 48]. One potential explanation for the better implementing of CR during the patients stay in the hospital could be a better involvement of the nurses in the CR process. An international survey of healthcare professionals in CR confirm that nurses were frequently responsible for delivering remote and technology-enabled rehabilitation, especially as programs rapidly adapted to pandemic restrictions [49]. In Romania, the perception is that the access to CR is extremely low or even non-existent (in remote areas) [50]. Patients are not addressed to these specialized centers, even if there is an increasing level of evidence that CR can improve endothelial dysfunction and its consequences [51] and symptoms related to heart failure [52, 53]. Romanian authors have even proved that pacemaker reprogramming can help the CR process [54] and CR combined with vitamin D supplementation can even reduce the episodes of arrythmia caused by right ventricular outflow tract premature ventricular contractions [55]. Interestingly, we have published in 2023 a study that the COVID-19 pandemic more cases of cancer diagnosis, and less implementation of prehabilitation procedures. This could partially be explained due to less involvement from the nurses (comparing to the situation of patients with T2DM and MS). They prefer to let the doctors discuss the cancer diagnosis with the patients [56]. The future years must enhance the prescription of CR and grow the population self-awareness that these techniques have a positive effect on relieving symptoms and improve their quality of life.

The study has several limitations, including relatively small patient cohorts and a limited evaluation of other clinical factors, such as symptoms, comorbidities, and lifestyle influencing factors. We have previously described the importance of rehabilitation in COPD [57], but in this study it was not recorded wheter the patients had a confirmed diagnosis of COPD or asthma. Another limitation is the lack of follow-up on CR adherence. Additionally, we acknowledge that some patients from the COVID-19 period may have experienced symptoms related to long-COVID syndrome, which was challenging to assess accurately based on the available patient registries.

However, its strengths lie in addressing outcomes that are underrepresented in the literature and the observation that more T2DM patients with cardiovascular comorbidities benefited from CR in the COVID-19 pandemic (year 2021) compared to an year prior the pandemic.

4. Materials and Methods

This study was conducted at the IV Medical Clinic - CF Cluj-Napoca Clinical Hospital between January and June 2025, utilizing a retrospective and analytical design. A database was compiled from patients admitted to this hospital during the year before the COVID-19 pandemic (2018) and during the pandemic year of 2021. Two groups, each consisting of 60 patients, were formed by randomly selecting 5

patients from each month of the respective years to ensure homogeneity. Computer randomization ensured an equal number of men and women in both groups (29 men and 31 women in each, because slightly more women were admitted in the hospital each of the studied years).

Patients were randomly selected from the CF Cluj-Napoca Clinical Hospital's integrated computer program, provided they met the inclusion criteria: diagnosis of Type 2 Diabetes Mellitus (T2DM) and age over 30 years. Following random allocation, clinical observation sheets were reviewed, and all pertinent clinical (anthropometric and data from clinical semiology) and significant paraclinical information (such as HbA1c for the assessement of T2DM control and the lipid profile for a complete diagnosis of the MS) was recorded.

The study was designed as a retrospective descriptive study, and it adhered to the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for reporting observational studies.

The Ethics Committee of CF Cluj-Napoca Clinical Hospital approved the study, and no informed consent was required since the study was not prospective. Data collected included general patient information, reasons for seeking medical attention, family and personal medical history, living and working conditions, and medication usage. Disease history elements and pathological findings from objective examinations were also documented.

The collected data were entered into an Microsoft Excel database and analyzed statistically using PivotTable and Charts. The data were further interpreted using the statistical software program GraphPad Prism 6.0. Continuous variables were analyzed using the Student t-test (for normally distributed variables per the Shapiro-Wilk Test) and the Mann-Whitney U Test or Chi-Square Test, as appropriate.

5. Conclusions

In the period of the COVID-19 pandemic, a significant shift was observed in the profile of diabetic patients admitted to CF Clinical Hospital in Cluj-Napoca. When comparing data from 2021, during the pandemic, with the pre-pandemic year of 2018, several notable changes emerged. The patients with T2DM admitted in 2021 were more prone to be hypertensive, with higher values of blood pressure, with poorer control of their T2DM, and with more cardiovascular comorbidities. Thus, the COVID-19 pandemic had a detrimental impact on the profile of patients with T2DM admitted to CF Clinical Hospital. Interestingly, between the same groups, it has been observed that more patients benefited from interventions of cardiac rehabilitation during the COVID-19 pandemic, probably due to more clear rules of management for doctors and better implementing of nursing interventions by hospital nurses.

Supplementary Materials: None.

Author Contributions: Conceptualization, M.V.M and T.G.A.; methodology, M.V.M., C.V.V, A.C.G., A.C. and O.H.O.; software, G.C.; validation, M.V.M., T.G.A., G.C., M.G.P. and L.C.; formal analysis, M.V.M., A.C., G.C. and C.V.V; investigation, M.V.M., A.C.G., T.G.A. and G.C.; resources, MV.M., N.V.L. and O.H.O.; data curation, O.H.O, T.G.A and L.C..; writing—original draft preparation, M.V.M., A.C.G., L.C., M.G.P. and N.V.L.; writing—review and editing, M.V.M, A.C.G., M.G.P. and L.C.; visualization, O.H.O., A.C. and M.V.M.; supervision, M.V.M. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Approved by an internal IRB of the CF Clinical Hospital.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: None.

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

References

1. Lavi N, Sasiarini L, Tjahjono CT. Cardiovascular Rehabilitation in Patients with Diabetes Mellitus. Clinical and Research Journal in Internal Medicine. 2022;3(2):332–9.
2. Portuguesa De Cardiologia R, Toste S, Viamonte S, Barreira A, Fernandes P, Lopes Gomes J, et al. Cardiac rehabilitation in patients with type 2 diabetes mellitus and coronary disease: A comparative study [Internet]. 2014. Available from: www.revportcardiol.org
3. Viigimaa M, Sachinidis A, Toumpourleka M, Koutsampasopoulos K, Alliksoo S, Titma T. Macrovascular Complications of Type 2 Diabetes Mellitus. Curr Vasc Pharmacol. 2020;18(2):110-116.
4. Katayama S, Hatano M, Issiki M. Clinical features and therapeutic perspectives on hypertension in diabetics. Hypertens Res. 2018 Apr;41(4):213-229.
5. Muhamad SA, Ugusman A, Kumar J, Skiba D, Hamid AA, Aminuddin A. COVID-19 and Hypertension: The What, the Why, and the How. Front Physiol. 2021 May 3;12:665064.
6. Javid FA, Waheed FA, Zainab N, Khan H, Amin I, Bham A, Ghoghawala M, Sheraz A, Haloub R. COVID-19 and diabetes in 2020: a systematic review. J Pharm Policy Pract. 2023 Mar 9;16(1):42.
7. Ciarambino T, Ciaburri F, Paoli VD, Caruso G, Giordano M, D'Avino M. Arterial Hypertension and Diabetes Mellitus in COVID-19 Patients: What Is Known by Gender Differences? J Clin Med. 2021 Aug 23;10(16):3740.
8. Sun M.L., Yang J.M., Sun Y.P., Su G.H. Inhibitors of RAS might be a good choice for the therapy of COVID-19 pneumonia. Zhonghua Jie He He Hu Xi Za Zhi. 2020;43:219–222.
9. Onder G., Rezza G., Brusaferro S. Case-fatality rate and characteristics of patients dying in relation to COVID-19 in Italy. JAMA. 2020 doi: 10.1001/jama.2020.4683.
10. Perkeni. Konsensus Pengelolaan dan Pencegahan Diabetes Melitus Tipe 2 di Indonesia. PB Perkeni; 2021.
11. Jiménez-Navarro MF, Lopez-Jimenez F, Pérez-Belmonte LM, Lennon RJ, Diaz-Melean C, Rodriguez-Escudero JP, et al. Benefits of cardiac rehabilitation on cardiovascular outcomes in patients with diabetes mellitus after percutaneous coronary intervention. Journal of the American Heart Association. 2017 Oct 1;6 (10).
12. Hansen D, Kraenkel N, Kemps H, Wilhelm M, Abreu A, Pfeiffer AFH, et al. Management of patients with type 2 diabetes in cardiovascular rehabilitation. European Journal of Preventive Cardiology. 2019 Dec 1;26(2_suppl):133–44.
13. Perki. Panduan Rehabilitasi Kardiovaskuler. First Edit. 2019.
14. Bassi-Dibai D, Santos-de-Araújo AD, Dibai-Filho AV, de Azevedo LFS, Goulart C da L, Luz GCP, et al. Rehabilitation of Individuals With Diabetes Mellitus: Focus on Diabetic Myopathy. Vol. 13, Frontiers in Endocrinology. Frontiers Media S.A.; 2022.
15. Kawamura T, Muraoka I. Exercise-Induced Oxidative Stress and the Effects of Antioxidant Intake From a Physiological Viewpoint. Antioxid (Basel Switzerland) (2018) 7:1–19. doi: 10.3390/ANTIOX7090119
16. Acosta-Manzano P, Rodriguez-Ayllon M, Acosta FM, Niederseer D, Niebauer J. Beyond General Resistance Training. Hy-pertrophy Versus Muscular Endurance Training as Therapeutic Interventions in Adults With Type 2 Diabetes Mellitus: A Sys-tematic Review and Meta-Analysis. Obes Rev (2020) 21:1–35. doi: 10.1111/OBR.13007
17. da Rocha RB, Silva CS, Cardoso VS. Self-Care in Adults With Type 2 Diabetes Mellitus: A Systematic Review. Curr Diabetes Rev (2020) 16:598–607. doi: 10.2174/1573399815666190702161849 71.
18. Bekele H, Asefa A, Getachew B, Belete AM. Barriers and Strategies to Lifestyle and Dietary Pattern Interventions for Prevention and Management of TYPE-2 Diabetes in Africa, Systematic Review. J Diabetes Res (2020) 2020:1–14.doi: 10.1155/2020/7948712
19. Callisaya ML, Daly RM, Sharman JE, Bruce D, DavisTME, Greenaway T,etal. Feasibility of a Multi-Modal Exercise Program on Cognition in Older Adults With Type 2 Diabetes– A Pilot Randomised Controlled Trial. BMC Geriatr (2017) 17:1–10. doi: 10.1186/S12877-017-0635-9
20. Rodriguez-Mañas L, Laosa O, Vellas B, Paolisso G, Topinkova E, Oliva Moreno J, et al. Effectiveness of a Multimodal Intervention in Functionally Impaired Older People With Type 2 Diabetes Mellitus. J Cachexia Sarcopenia Muscle (2019) 10:721–33. doi: 10.1002/JCSM.12432
21. Izquierdo M, Laosa O, Cadore EL, Abizanda P, Garcia-Garcia FJ, Hornillos M, et al. Two-Year Follow-Up of a Multimodal Intervention on Functional Capacity and Muscle Power in Frail Patients With Type 2 Diabetes. J Am Med Dir Assoc (2021) 22:1906–11. doi: 10.1016/J.JAMDA.2021.06.022
22. Sahin C, Courtney KL, Naylor P, Rhodes RE. Tailored Mobile Text Messaging Interventions Targeting Type 2 Diabetes Self-Management: A Systematic Review and A meta-analysis. Digit Heal (2019) 5:205520761984527.doi: 10.1177/2055207619845279
23. Huo X, Krumholz HM, Bai X, Spatz ES, Ding Q, Horak P, et al. Effects of Mobile Text Messaging on Glycemic Control in Patients With Coronary
24. Drwal KR, Forman DE, Wakefield BJ, el Accaoui RN. Cardiac Rehabilitation during COVID-19 Pandemic: Highlighting the Value of Home-Based Programs. Telemedicine and e-Health. 2020 Nov 1;26(11):1322–4.

25. Mandu M., Olteanu G., Lăcraru A.E., Onose G., Lazăr N. , Șerbănoiu , Ciucă-Pană M.A., Andone I., Spinu A., Vataman A.A., Dogaru G., Busnatu Ș. - Cardiac rehabilitation centers in Romania: Where are we now? Balneo and PRM Research Journal. 2024,15(2):707.
26. Grossman A, Grossman E. Blood pressure control in type 2 diabetic patients. Cardiovasc Diabetol. 2017 Jan 6;16(1):3.
27. Mueller AL, McNamara MS, Sinclair DA. Why does COVID-19 disproportionately affect older people? Aging (Albany NY). 2020 May 29;12(10):9959-9981.
28. Daly J, Depp C, Graham S, Jeste D, Kim H, Lee E, Nebeker C. Health Impacts of the Stay-at-Home Order on Community-Dwelling Older Adults and How Technologies May Help: Focus Group Study. JMIR Aging 2021;4(1):e25779.
29. Weiner SG, Cash RE, Hendricks M, El Ibrahimi S, Baker O, Seethala RR, Peters G, Goldberg SA. Ambulance Calls for Sub-stance-Related Issues Before and After COVID-19. Prehosp Emerg Care. 2021 Nov-Dec;25(6):768-776.
30. Webb LM, Chen CY. The COVID-19 pandemic's impact on older adults' mental health: Contributing factors, coping strategies, and opportunities for improvement. Int J Geriatr Psychiatry. 2022 Jan;37(1):10.1002/gps.5647.
31. Daniels NF, Burrin C, Chan T, Fusco F. A Systematic Review of the Impact of the First Year of COVID-19 on Obesity Risk Factors: A Pandemic Fueling a Pandemic? Curr Dev Nutr. 2022 Apr 8;6(4):nzac011.
32. Nour TY, Altintaş KH. Effect of the COVID-19 pandemic on obesity and it is risk factors: a systematic review. BMC Public Health. 2023 May 30;23(1):1018.
33. Sanchis-Gomar F, Lavie CJ, Neeland IJ, Lippi G. Does abdominal obesity influence immunological response to SARS-CoV-2 infection? Expert Rev Endocrinol Metab. 2021 Nov;16(6):271-272.
34. Nadar SK, Tayebjee MH, Stowasser M, Byrd JB. Managing hypertension during the COVID-19 pandemic. J Hum Hypertens. 2020 Jun;34(6):415-417.
35. Khairy Y, Naghibi D, Moosavi A, Sardareh M, Azami-Aghdash S. Prevalence of hypertension and associated risks in hos-pitalized patients with COVID-19: a meta-analysis of meta-analyses with 1468 studies and 1,281,510 patients. Syst Rev. 2022 Nov 17;11(1):242.
36. Gallo G, Calvez V, Savoia C. Hypertension and COVID-19: Current Evidence and Perspectives. High Blood Press Cardiovasc Prev. 2022 Mar;29(2):115-123.
37. Cassell K, Zipfel CM, Bansal S, Weinberger DM. Trends in non-COVID-19 hospitalizations prior to and during the COVID-19 pandemic period, United States, 2017-2021. Nat Commun. 2022 Oct 8;13(1):5930.
38. Dang A, Thakker R, Li S, Hommel E, Mehta HB, Goodwin JS. Hospitalizations and Mortality From Non-SARS-CoV-2 Causes Among Medicare Beneficiaries at US Hospitals During the SARS-CoV-2 Pandemic. JAMA Netw Open. 2022 Mar 1;5(3):e221754.
39. Gasch-Illescas A, Calle-Serrano M, Vallejo-Vaz AJ, Praena-Fernández JM, Guerrero JA, Calderón EJ, Pollán M, Medrano FJ. Impact of the first wave of the COVID-19 pandemic on non-COVID inpatient care in southern Spain. Sci Rep. 2023 Jan 30;13(1):1634.
40. Soria A, Galimberti S, Lapadula G, Visco F, Ardini A, Valsecchi MG, Bonfanti P. The high volume of patients admitted during the SARS-CoV-2 pandemic has an independent harmful impact on in-hospital mortality from COVID-19. PLoS One. 2021 Jan 28;16(1):e0246170.
41. Makhoul E, Aklinski JL, Miller J, Leonard C, Backer S, Kahar P, Parmar MS, Khanna D. A Review of COVID-19 in Relation to Metabolic Syndrome: Obesity, Hypertension, Diabetes, and Dyslipidemia. Cureus. 2022 Jul 29;14(7):e27438.
42. McDonagh ST, Dalal H, Moore S, Clark CE, Dean SG, Jolly K, Cowie A, Afzal J, Taylor RS. Home-based versus centre-based cardiac rehabilitation. Cochrane Database Syst Rev. 2023 Oct 27;10(10):CD007130.
43. Thomas RJ. Cardiac Rehabilitation - Challenges, Advances, and the Road Ahead. N Engl J Med. 2024 Feb 29;390(9):830-841.
44. Wang Y, Shi H, Zhang M, Duan Y, Li Z, Chen L, Wu Y, Ren Y, Lu Y. Self-Management-Centric Cardiac Rehabilitation for Acute Coronary Syndrome Patients During the COVID-19 Pandemic. Med Sci Monit. 2025 Jun 9;31:e947235.
45. Ozemek C, Berry R, Bonikowske AR, German C, Gavic AM. What has cardiac rehabilitation looked like in the COVID-19 pandemic: Lessons learned for the future. Prog Cardiovasc Dis. 2023 Jan-Feb;76:20-24.
46. Aoyagi Y, Mori E, Ishii H, Kono Y, Sato A, Okochi Y, Funahashi R, Kagaya H. Poor walking ability outcome and activities of daily living improvement in patients undergoing cardiac rehabilitation during COVID-19 pandemic. Eur J Phys Rehabil Med. 2022 Aug;58(4):606-611.
47. Haskiah F, Jbara R, Minha S, Assali A, Sela Y, Pereg D. The impact of COVID-19 pandemic on cardiac rehabilitation of pa-tients following acute coronary syndrome. PLoS One. 2022 Dec 1;17(12):e0276106.
48. Varghese MS, Beatty AL, Song Y, Xu J, Sperling LS, Fonarow GC, Keteyian SJ, McConeghy KW, Penko J, Yeh RW, Figueroa JF, Wu WC, Kazi DS. Cardiac Rehabilitation and the COVID-19 Pandemic: Persistent Declines in Cardiac Rehabilita-tion Participation and Access Among US Medicare Beneficiaries. Circ Cardiovasc Qual Outcomes. 2022 Dec;15(12):e009618.
49. O'Doherty AF, Humphreys H, Dawkes S, Cowie A, Hinton S, Brubaker PH, Butler T, Nichols S. How has technology been used to deliver cardiac rehabilitation during the COVID-19 pandemic? An international cross-sectional survey of healthcare professionals conducted by the BACPR. BMJ Open. 2021 Apr 20;11(4):e046051.

50. Ciucă-Pană M.A., Ion A., Șerbănoiu L.I., Cojocaru V., Olteanu G., Andronic O., Lăcraru A., Andrei C., Sinescu C., Suceveanu M.C., Mandu M., Onose G., Pedretti R., Niebauer J., Ștefan-Busnatu S.S. - Assessment of on-site and remote cardiac rehabilita-tion in Romania. Balneo and PRM Research Journal. 2023,14(4):621.
51. Cozma, A., Sitar-Taut A.V., Fodor A., Oltean M., Minciuna I.A., Minciuna I., Matuz R., Răcătăianu N., Dogaru G., Orasan O. Evaluation of endothelial dysfunction and its improvement after cardiac rehabilitation. Balneo Research Journal. 2018.9(4).364-375.
52. Ganea A., Guşetu G., Caloian B., Zdrenghea D., Pop D. - The role of cardiac rehabilitation in patients with atrial fibrillation and heart failure. Balneo and PRM Research Journal. 2024,15(1):649.
53. Nicoara A.D., Alexandrescu L., Tofolean D.E., Iliescu M.G., Condur L.M., Tofolean I.T. - The Impact of Cardiac Rehabilita-tion on Quality of Life in Elderly Heart Failure Patients-Literature Review. Balneo and PRM Research Journal. 2024, 15(3):723.
54. Caloian B., Irimie D.A., Gusetu G.N., Comsa D.H., Cismaru G.L., Fringu F.I., Tomoaia R., Rosu R.O., Dadarlat-Pop A., Pop D., Zdrenghea D.T. - Optimizing cardiac rehabilitation by pacemaker reprogramming. Can we immediately improve the exercise capacity? Balneo and PRM Research Journal. 2023,14(3):577.
55. Cismaru G., Gurzau D., Fringu F., Martis A., Caloian B., Comsa H., Gusetu G., Puiu M., Istratoaie S., Cismaru A., Rosu R., Pop D., Zdrenghea D. Vitamin D supplementation with Cardiac Rehabilitation reduces the number of RVOT Premature. Bal-neo Research Journal. 2020,566-568.
56. Ciumărnean L., Milaciu M., Vesa S., Rebeleanu C., Orășan O., Para I., Leach N., Hiriscau E., Dogaru G. The COVID-19 pan-demic has revealed an increase in cancer diagnoses and a decrease in prehabilitation programs among patients in Transylva-nia. Balneo and PRM Research Journal. 2023, 14.600.
57. Alexescu T., Maierean A., Ciumărnean L., Budin C., Dogaru Gabriela., Todea A.T. Rehabilitation therapies in stable chron-ic obstructive pulmonary disease. Balneo Research Journal. 2019.10(1).37-44.