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Professional paper

APPLICATION OF CERTAIN CARDIOLOGICAL AND KINESIOLOGICAL PROTOCOLS DURING THE PROCESS OF REHABILITATION OF THE PATIENTS WITH ACUTE MYOCARDIAL INFARCTION

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Abstract

This study focuses on evaluating the effects of a specific kinesitherapeutic treatment protocol with duration of 21 days on the functional and biochemical parameters in patients recovering from acute myocardial infarction. The rationale behind this investigation lies in the growing body of evidence suggesting that structured physical activity can positively influence cardiovascular health, functional capacity, and overall well-being. The study conducted once more proves the importance of physical activity on general health and the functionality of the cardiovascular system in particular.

Keywords: kinesiology, acute myocardial infarction, biochemical parametres, functional parametres

1. Introduction

Acute myocardial infarction (AMI) is a critical cardiovascular event with profound implications for both short-term and long-term patient health. While advancements in medical interventions have significantly improved survival rates, the post-AMI recovery phase remains a crucial period where comprehensive therapeutic strategies are essential. In recent years, kinesitherapeutic interventions, encompassing targeted physical exercises and movement-based therapies, have gained recognition for their potential role in cardiac rehabilitation (CR).

The functional parameters under scrutiny include measures such as exercise tolerance, cardiac function, and quality of life indicators. Exercise tolerance, often assessed through standardized stress tests, provides valuable insights into the cardiovascular system's ability to meet the body's demands. Cardiac function parameters, including ejection fraction and ventricular performance, offer a glimpse into the heart's recovery and adaptation post-infarction. Concurrently, assessing the impact on patients' quality of life provides a holistic perspective on the effectiveness of kinesitherapeutic interventions in fostering a sense of well-being and overall health (Dibben GO, et al.2018)

On the biochemical front, the study delves into markers associated with cardiac health, inflammation, and metabolic function (Taylor, R. S., Dalal, H. M., & McDonagh, S. T. J. 2022). Biochemical parameters such as troponin levels, lipid profiles, and inflammatory markers offer valuable information regarding the physiological response to the kinesitherapeutic treatment (Ades, P. A., Green, N. M., & Coello, C. E. 2003.). Understanding how these markers evolve over the 21-day duration provides crucial insights into the treatment's impact on the underlying pathophysiological processes associated with AMI. Physical exercise inclusion in CR programs resulted in several beneficial effects on cardiovascular functional capacity, quality of life, risk factor modification, psychological profile, hospital readmissions, and mortality (Arnett, D.K.; Blumenthal, et.al, 2019). Such

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benefits can be justified by a 20% reduction in mortality from all causes and in the levels of cardio-respiratory fitness (CRF) for each metabolic equivalent improvement (MET) in CRF of patients with AMI (Anderson, L.; et.al.2016). Exercise programs for patients with AMI traditionally involve mostly low- to moderate intensity continuous aerobic exercise training, with the consensus that one of the benefits of aerobic exercise is the increase in peak oxygen uptake (VO_2 peak) (Mezzani, A.;et,al.2016–Wisloff, U.;et.al.2007) During the last two decades, several studies have demonstrated that high-intensity exercise protocols induce more beneficial cardiovascular adaptations in patients with mild-to-severe heart disease when compared to moderate-intensity exercise protocols (Wisloff, U.;et.al.2007, Warburton, D.E.;et.al.2005, Cornish, A.K.;et.al.2010). A recent research reported higher improvements in maximal aerobic capacity after high-intensity interval training (HIIT) programs compared to moderate-intensity programs. (Mitchell, B.L.;et.al.2018). Nevertheless, the optimum exercise intensity prescription in patients with AMI is still a subject of debate. A recent systematic review on the topic (Hannan, A.L.;et.al.2018) did not report optimal intensity prescription (e.g., the intensity interval that is most effective during exercise interventions to induce favorable changes in aerobic capacity). Thus, despite the literature being replete with studies showing that regular and structured exercise is beneficial for AMI patients, the optimal intensity and length of exercise interventions that bring about greater benefits remain equivocal. Hence, the objective of this research was to identify, through Randomized Controlled Trials (RCTs) of exercise-based CR, the most effective exercise intensity and intervention length to optimize VO_2 peak in patients with AMI.

2. Aim of the study

This research aims to contribute to the growing body of knowledge surrounding the potential benefits of kinesitherapeutic interventions in the comprehensive rehabilitation of patients following acute myocardial infarction. By systematically examining both functional and biochemical parameters over a 21-day period, the study seeks to elucidate the nuanced effects of this specific treatment modality, as well as establishing of the effects of certain kinesitherapeutic treatment with duration of 21 days in center for cardiac rehabilitation.

3. Material and Methods

At the Center for prevention, curing and rehabilitation from heart diseases St. Stefan in Ohrid, during the process of rehabilitation of the patients with different heart diseases and especially the patients who suffered acute myocardial infarction, numerous diagnostic protocols are applied. The cardiac rehabilitation is based on application of protocols from kinesiology, cardiovascular testing, biochemical analysis and support from clinical psychologist.
With the prior consent and request by the patient, after the establishing of the health condition of the patient by a general practitioner, an admission of the patient at the institution takes place at previously determined time and place. The patient is placed in a room which is previously reserved and usually in the room there could be only two or three patients accommodated. At the first day of the stay at the hospital the following analysis are made: biochemical analysis, full blood analysis, sedimentation of erythrocytes, metabolic research, HDL, LDL total cholesterol, triglycerides, acidum uricum, electrolyte and hormonal status, rheumatic factor, AST and ALT.
Telemetric analysis, clinical and electrocardiographic analysis by use of a monitor is applied, tracking of the EKG while walking on a flat surface 300 meters long with a moderate tempo of walking.

The first and the second veloergometric test is applied during loading tests when different protocols are used. A common characteristic is the gradual increase of the loading, the stage of every level is limited from 3 to 5 minutes. The loading is usually continuous. For conducting of the tests veloergometre bicycle and treadmill according to the intensity, the tests could be submaximal and maximum. In the cardiology more frequently submaximal tests are used which are aborted when 85-90 % of the predicted maximum heart rate is reached for the determined age.
Veloergometric loading test is more difficult for applying particularly among elderly people, but technical good EKG is produced when it is applied. Also, the level of loading depends of the body weight of the patient. The loading starts with 25 or 50 watts and it increases on every next level for 25 watts. After the analysis of the results of the testing it could be determined whether the test is negative, with average values or positive-pathological.
On the second day Echocardiography is applied, with aim the dimensions of the right and the left atriums of the heart to be determined, the valves of the heart, the pressure of the pulmonary artery and the aorta trunk, the total strength of the myocardial muscle is evaluated-heart ejection fraction which could be the following:

- Possible heart failure 15-30%
- Low function 30-50%
- Normal function 50-55%
- High function 60-70%

Sample

A number of 119 participants who fulfilled the eligibility criteria were enrolled in the study. All the participants were males at the age under 65, according to the general classification of the cardiovascular patients in this study the produced results were isolated from the first and the second velometric tests at the male patients under age 65. Certain cardiologic protocols took place for these patients including biochemical research, coronary stress test and two veloergometric tests-initial and final test. After the finishing of these protocols the functional capacities of the patients are determined, bearing in mind the heart ejection fraction and the level of loading in watts such as their metabolic values. The produced results serve as indexes for application of the kinesitherapeutic treatment which is conducted for 21 days. After the finishing of the above mentioned cardiological protocols the results of the patients are accessible to the exercise physician. After the results analysis, especially of the functional testing, group of patients is selected, according to their functional abilities which are indices for the planning and programming of the rehabilitation training. In the introductory segment of the training, exercises for breathing and warm up are applied. The basic principle for determining of the complex of exercises for warm up is individuals which is based on the objective findings and the clinical procedure followed by the cardiologist who recommends kinesiotherapy as best means for curing of the cardiovascular diseases. According to the NYHA the warm up exercises and the breathing exercises are divided into four groups. In this study at patients the exercises from the second group were applied because the patients who are being rehabilitated have undergone cardio-surgical intervention such as bypass or stent. These exercises include:

- Breathing exercises
- Exercises for the head and the neck
- Exercises for the shoulders
- Exercises for elbows
- Exercises for wrists

- Exercises for the torso and the lower back
- Exercises for the hip
- Exercises for the knee
- Exercises for the ankle
- Standing tiptoe

The kinesitherapeutical treatment (physical training) starts in the morning with duration of 15-30 minutes. In the introductory segment of the training the warm up exercises from the second group are applied. Prior to the start of the rehabilitating training, ECG electrodes are applied on the patient chest and the rehabilitation training parameters are monitored, so that the dysfunction of the cardio-vascular activity does not occur during the training. Prior to the start of the main part of the physical training the heart rate is measured as well as at the end of the activity. The training that is performed on the special cardio rehabilitation equipment lasts for 30 minutes such as:

-Working out on a stair climber machine - A vertical climbing movement is performed with duration of 30 minutes active climbing.

- **Veloergometric** – the patient regulates the height of the seat by oneself according to the

patients height, afterwards the activity commences. The initial loading is 10 watts, and afterwards gradual increase of the loading occurs after every third minute by 8 watts up until the point of 50 watts loading happens up until the 15^{th} minute of the intensity of the workout. After the 15^{th} minute every third minute the loading is decreased by 8 watts up until the 30^{th} minute of the training.

- **Treadmill** - this equipment is used starting with the velocity of 1 km/h. The velocity is increased every third minute by 1 km/h up until the 15^{th} minute of the activity. After the 15^{th} minute every third minute the velocity is decreased by 1 km/h up until the 30^{th} minute of the activity.
- **Individual walking for 1 hour** - cardiovascular telemetry is performed by walking on flat surface with slight incline from 0 to 2.8 degrees. The patients could divide the activity in two sets each lasting for 30 minutes (2x30 min.).

After the realization of the complete protocol that lasts for 21 days including the cardiorespiratory training, the second-final veloergometric test was applied. The received results for establishing of the differences in the researched variables, i.e. to establish the effects of the kinesiological treatment, certain calculations were applied on the basic statistical indexes and an appropriate T –test. The complete processing of the received results was processed by use of the statistical package of the programme, Statistics for Windows 5.0

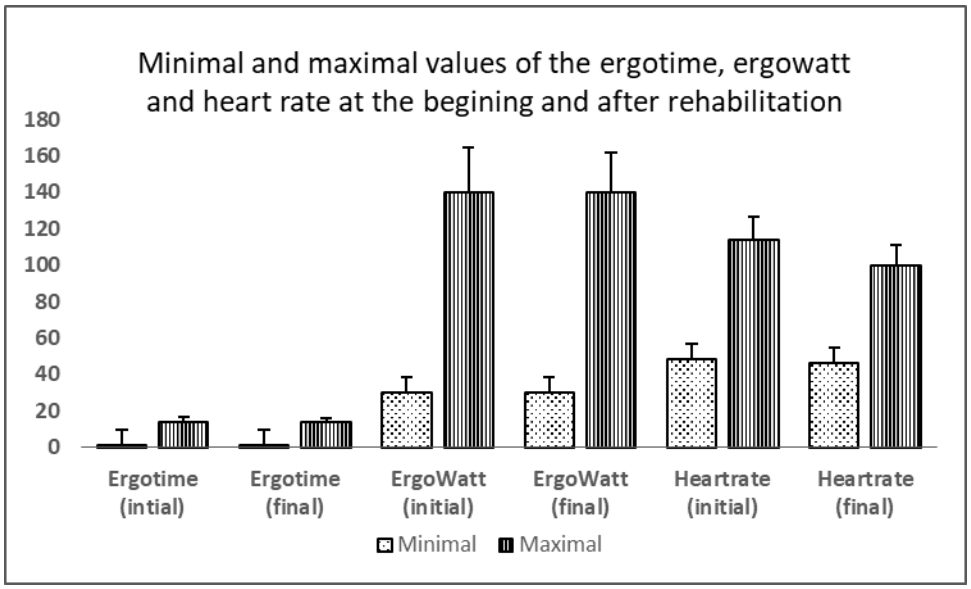
4. Data analysis and results

In the process of the data processing ten variables in total were applied out of which six are biochemical: LDL, HDL, Tryglicerides, Glucose, Hemoglobin, Eritrocites and four functional: Systolic and diastolic blood pressure, Ergotime, Erowatt, Heartrate1, which are present in the patients with previously determined AMI who had previously undergone surgical operation (bypass and stent placement). Because of the protocol of the Center for rehabilitation St. Stefan in Ohrid in the second measuring only the functional variables would be taken into consideration.

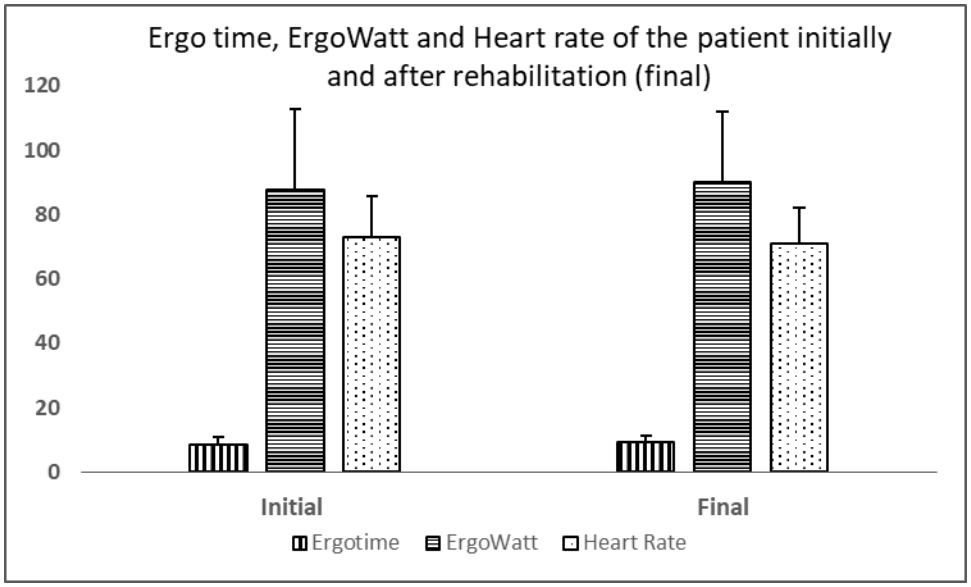
Table.1 Basic statistical indexes of the measured variable at the participants aged under 65 with AMI in initial measuring N119.

Variables	N	Mean	Min.	Max.	Std.Dev.	Skewness	Kurtosis
Systolic	119	129.16	90.00	180.00	16.07	.60	1.22
Diastolic	119	80.80	50.00	110.00	10.35	-.85	4.68
Eritro	119	5.01	3.36	6.60	.51	-.29	1.51
Hemoglob	119	14.35	9.20	18.60	1.57	-.16	.49
Glucose	119	5.54	3.18	14.78	1.90	2.04	5.08
Tryglicer	119	2.24	.45	7.6	6.87	10.65	11.5
HDL	119	2.04	.63	9.5	8.63	10.78	11.7
LDL	119	2.25	.63	4.3	.83	.50	-.04
Ergo1time	119	8.56	1.0	14.00	2.30	-.41	.15
Ergowatt	119	87.90	30.00	140.00	24.87	.01	-.08
Heartrate1	119	73.09	48.00	113.00	12.69	.58	.48

In the space of the descriptive statistics of the measurable variables from the group of participant of age under 65 who suffered AMI in the initial measuring N-119 which are shown in table 1. On the basis of the produced skewness results it could be noticed noticeable statistical digression of the variables –GLUCOSE - 2.04, triglycerides -10.65, and the variable HDL -10.78. According to the Kurtosis, it could be noticed its statistical digression at the variables triglycerides -115.21, HDL -117.02, diastolic blood pressure -4.68, and the variable GLUCOZE-5.08.As far as the Std. Dev. is concerned the greatest homogeneity is produced in the variable erytrocites-.51, while the greatest heterogeneity is present in ERGOWAT-23.56.
Observing the charts below where the basic statistical indexes are shown of the applied variables at the digressions of the skewness and kurtosis indexes are not noticed, while in the Std.Dev, the results show significant statistical homogeneity at the variable ERGOTIME-2.14 while the greatest digressions are noticed at the variable ERGOWAT-1.86.



Graph.1 Minimal and maximal values that where noticed during the initial phase and after 21 day of rehabilitation of the variables taken from ergotime, ergowatt and the heart rate of the enrolled patients.



Graph.2 Mean values and standard deviation values that where noticed during the initial phase and after 21 day of rehabilitation of the variables taken from ergotime, ergowatt and the heart rate of the enrolled patients.

In the table 3 where T-test differences are shown between the initial and the final measuring in the kinesiological variables for assessment of the functional ability of the cardio-vascular system measured by the ergometric test at the group of participants who suffered AMI at the age under 65 N-119, it could be noticed a noticeable statistical difference only in the variable ERGOTIME. The T-test shows value of-2.10 with significance level of P-.04.

Table 2. T-test differences

Variables	Mean G_1:1	Mean G_2:2	t-value	df	p
ERGOTIME	**8.34**	**8.97**	**-2.84**	**176**	**.00***
ERGOWATT	83.36	85.48	-.88	176	.38
HEARTRATE	73.44	71.49	1.50	176	.13

The average values* Mean of the variable ERGOTIME as well as in all the participants, table 3 shows increase of the duration of the test, which in essence presents increased values of the aerobic potentials of the participants in the clinical protocol lasting for 21 days.
For the needs of this study a division of the participants is created where the male population under the age of 65 is still unretired. Observing the produced results it is noticeable that the number of the patients who suffered AMI is approximately bigger than the patients who suffered AMI over age of 65. As far as the group of participants under 65 with AMI is concerned in the initial measuring N-119 it is noticeable that the average values of the parameters taken in this study are in the limits of the reference values for the sex and the age of the participants. Exceptions to this are the variables-GLUCOSE, triglycerides, HDL, LDL. As far as the final measuring is concerned in the group of under 65 N 119 the variables produced from the test ergo-bicycle show towards normal distribution of the same. Also, the homogeneity of the results is greatest in the variable ERGOTIME, but the greatest heterogeneity is noticed in the variable ERGOWAT (chart 2). This fact was also previously stated and it was stated relating the fact that the rehabilitation protocol is very sensitive in the sense of intensity of the workout that could present a weakness for the protocol itself. Particularly interesting are the data from the T-test for the differences in relation to the veloergometric variables, namely in the group of participants at the age of under 65, according

to the applied test certain statistical differences are noticed in the variable ERGOTIME. It could be affirmed that the rehabilitation protocol is not sufficiently sensitive for the people who have suffered from AMI i.e the same protocol does not produce any changes neither in the quantity nor the quality of the functional status of the participants.

5. Discussion

Continuous aerobic exercise training implicates higher durations under moderate-intensity and nonvariable aerobic activity (60–80% of VO_2 peak) (Rojhani-Shirazi, Z.;et.al.2018), Giallauria, F.;et.al.2013), compared to high-intensity protocols, which consist of intermittent, short high-intensity work periods (85–100% of VO_2 peak) with relative resting periods (Villelabeitia-Jaureguizar, K.;et.al.2017, Tamburús, N.Y.; Tamburús, N.Y.;et.al.2015). Exercise intensity appears to influence the number of cardio-protective benefits achieved from aerobic exercise (Beckie, T.M.;et.al.2014Rivera-Brown, A.M.;et.al.2012). The current consensus recommends that exercise intensity prescribed for patients with CVD should be approximately 60% of the maximal heart rate (MHR), 50% of the heart rate reserve (HRR), or 12–13 on the Borg scale. Intensities around 85% MHR, 80% HRR, or 15–16 on the Borg scale should represent the upper limits (Mezzani, A.;et.al.2013). Additionally, high-intensity protocols (85–100% of VO_2 peak) appear to be of particular interest to scientists, considering their application in patients with AMI based on the effects on the cardio-respiratory and muscle systems (Moholdt, T.;et.al.2011). High-intensity protocols elicit a greater training stimulus than moderate continuous exercise in improving maximal aerobic capacity (Wisloff, U.;et.al.2007, Cornish, A.K.;et.al.2010). In addition, high-intensity exercise appears to improve the limiting factors of VO_2 peak, and VO_2 peak itself has been found to be more effective in improving cardiovascular risk factors than moderate-intensity exercise (Warburton, D.E.;et.al.2005,Cornish, A.K.;et.al.2010]. Training sessions based on moderate-intensity continuous exercise have shown improvements in HRR after eight weeks [20] and after 12 weeks (Blumenthal, J.A.;et.al.2005, Kitzman, D.W.;et.al.2013). Moderate- to high intensity continuous exercise (6 and 12 MET, corresponding to 21 and 42 mL-kg−1 -min−1 of VO_2 peak) has also been shown to reduce all-cause mortality in healthy individuals, independent of activity duration (Moholdt, T.;et.al.2011), and reduce the risk of heart disease (Beckie, T.M.;et.al.2014), supporting the need to further investigate the potential health effects of protocols based on higher intensities**.** Referring the cardiovascular training that is applied in the rehabilitation center St. Stefan in Ohrid and the protocol of the research of the biochemical parameters which is applied on N=119 patients, in the initial measuring it is noticed that the average values of the parameters processed in this study are in the borders of the referent values related to the sex and the age of the patients. The exception to this are the variables: GLUCOSE, HDL, LDL.As far as the final measuring is concerned in the above mentioned group of patients, the received results of the veloergometric test show normal distribution of the ERGO2TIME and ERGO2WAT. Also the homogeneity is the highest in the variable ERGO2TIME, while the greatest heterogeneity is noticed in the variable ERGO2WAT. This statement was also previously analysed in relation to the fact that the programme for the cardiovascular training is less sensitive in relation to the intensity of the training and this could present a weakness of the same.

6. Conclusion

On the basis of the discussions above, a recommendation could be made that is directed towards an individualization or homogeneity of the kinesiological protocol according to the individual needs of the patients. By this all the aims of every rehabilitation protocol could be achieved altogether, and by that the same protocol would be beneficial for the patient. For complete realization of the physical training, experts from the field of kinesiology should be included in the protocol, more precisely experts from the branch of kinesiotherapy who in cooperation with the cardiologists could contribute towards more efficient realization of the physical training program for the successful recovery of the patients who are treated in a specialized rehabilitation centers.

References

[1] Ades, P. A., Green, N. M., & Coello, C. E. (2003). Effects of exercise and cardiac rehabilitation on cardiovascular outcomes. *Cardiology clinics*, *21*(3), 435–viii. https://doi.org/10.1016 /s0733-8651(03)00056-0

[2] Anderson, L.; Oldridge, N.; Thompson, D.R.; Zwisler, A.-D.; Rees, K.; Martin, N.; Taylor, R.S. Exercise-Based Cardiac Rehabilitation for Coronary Heart Disease. J. Am. Coll. Cardiol. 2016, 67, 1–12. [CrossRef] [PubMed]

[3] Arnett, D.K.; Blumenthal, R.S.; Albert, M.A.; Buroker, A.B.; Goldberger, Z.D.; Hahn, E.J.; Himmelfarb, C.D.; Khera, A.; LloydJones, D.; McEvoy, J.W.; et al. 2019 ACC/AHA Guideline on the Primary Prevention of Cardiovascular Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines. Circulation 2019, 140, e596–e646. [CrossRef]

[4] Blumenthal, J.A.; Sherwood, A.; Babyak, M.A.; Watkins, L.L.; Waugh, R.; Georgiades, A.; Bacon, S.L.; Hayano, J.; Coleman, E.R.; Hinderliter, A. Effects of exercise and stress management training on markers of cardiovascular risk in patients with ischemic heart disease—A randomized controlled trial. JAMA 2005, 293, 1626–1634. [CrossRef]

[5] Beckie, T.M.; Beckstead, J.W.; Kip, K.E.; Fletcher, G. Improvements in Heart Rate Recovery Among Women After Cardiac Rehabilitation Completion. J. Cardiovasc. Nurs. 2014, 29, 38–47. [CrossRef] [PubMed]

[6] Cornish, A.K.; Broadbent, S.; Cheema, B.S. Interval training for patients with coronary artery disease: A systematic review. Graefe's Arch. Clin. Exp. Ophthalmol. 2010, 111, 579–589. [CrossRef] [PubMed]

[7] Dibben GO, Dalal HM, Taylor RS, *et al*. Cardiac rehabilitation and physical activity: systematic review and meta-analysis *Heart* 2018;104**:**1394-1402.

[8] Giallauria, F.; Acampa, W.; Ricci, F.; Vitelli, A.; Torella, G.; Lucci, R.; Del Prete, G.; Zampella, E.; Assante, R.; Rengo, G.; et al. Exercise training early after acute myocardial infarction reduces stress-induced hypoperfusion and improves left ventricular function. Eur. J. Nucl. Med. Mol. Imaging 2013, 40, 315–324. [CrossRef]

[9] Giallauria, F.; Lucci, R.; D'Agostino, M.; Vitelli, A.; Maresca, L.; Mancini, M.; Aurino, M.; Del Forno, D.; Giannuzzi, P.; Vigorito, C. Two-year multicomprehensive secondary prevention program: Favorable effects on cardiovascular functional capacity and coronary risk profile after acute myocardial infarction. J. Cardiovasc. Med. 2009, 10, 772–780. [CrossRef] [PubMed]

[10] Giallauria, F.; Acampa, W.; Ricci, F.; Vitelli, A.; Maresca, L.; Mancini, M.; Grieco, A.; Gallicchio, R.; Xhoxhi, E.; Spinelli, L.; et al. Effects of exercise training started within 2 weeks after acute myocardial infarction on myocardial perfusion and left ventricular function: A gated SPECT imaging study. Eur. J. Prev. Cardiol. 2012, 19, 1410–1419. [CrossRef] [PubMed]

[11] Ghroubi, S.; Elleuch, W.; Abid, L.; Kammoun, S.; Elleuch, M.-H. The effects of cardiovascular rehabilitation after coronary stenting, Apport de la readaptation cardiovasculaire dans les suites d'une angioplastie transluminale. Ann. Phys. Rehabil. Med. 2012, 55, e307–e309. [CrossRef]

[12] Hannan, A.L.; Hing, W.; Simas, V.; Climstein, M.; Coombes, J.S.; Jayasinghe, R.; Byrnes, J.; Furness, J. High-intensity interval training versus moderate-intensity continuous training within cardiac rehabilitation: A systematic review and meta-analysis. Open Access J. Sports Med. 2018, 9, 1–17. [CrossRef]

[13] Kitzman, D.W.; Brubaker, P.H.; Herrington, D.M.; Morgan, T.M.; Stewart, K.P.; Hundley, W.G.; Abdelhamed, A.; Haykowsky, M.J. Effect of endurance exercise training on endothelial function

and arterial stiffness in older patients with heart failure and preserved ejection fraction: A randomized, controlled, single-blind trial. J. Am. Coll. Cardiol. 2013, 62, 584–592. [CrossRef]
[14] Mezzani, A.; Hamm, L.F.; Jones, A.M.; McBride, P.E.; Moholdt, T.; Stoner, J.A.; Urhausen, A.; Williams, A.M. Aerobic exercise intensity assessment and prescription in cardiac rehabilitation: A joint position statement of the European Association for Cardiovascular Prevention and Rehabilitation, the American Association of Cardiovascular and Pulmonary Rehabilitation and the Canadian Association of Cardiac Rehabilitation. Eur. J. Prev. Cardiol. 2013, 20, 442–467. [CrossRef]
[15] Mitchell, B.L.; Lock, M.J.; Davison, K.; Parfitt, G.; Buckley, J.P.; Eston, R.G. What is the effect of aerobic exercise intensity on cardiorespiratory fitness in those undergoing cardiac rehabilitation? A systematic review with meta-analysis. Br. J. Sports Med. 2018, 53, 1341–1351. [CrossRef] [PubMed]
[16] Moholdt, T.; Aamot, I.L.; Granøien, I.; Gjerde, L.; Myklebust, G.; Walderhaug, L.; Brattbakk, L.; Hole, T.; Graven, T.; Stølen, O.T.; et al. Aerobic interval training increases peak oxygen uptake more than usual care exercise training in myocardial infarction patients: A randomized controlled study. Clin. Rehabil. 2011, 26, 33–44. [CrossRef]
[17] Rivera-Brown, A.M.; Frontera, W.R. Principles of exercise physiology: Responses to acute exercise and long-term adaptations to training. PM R. 2012, 4, 797–804. [CrossRef] [PubMed]
[18] Rognmo, Ø.; Hetland, E.; Helgerud, J.; Hoff, J.; Slørdahl, S.A. High intensity aerobic interval exercise is superior to moderate intensity exercise for increasing aerobic capacity in patients with coronary artery disease. Eur. J. Cardiovasc. Prev. Rehabil. 2004, 11, 216–222. [CrossRef]
[19] Rojhani-Shirazi, Z.; Abolahrari-Shirazi, S.; Kojuri, J.; Bagheri, Z. Efficacy of combined endurance-resistance training versus endurance training in patients with heart failure after percutaneous coronary intervention: A randomized controlled trial. J. Res. Med. Sci. 2018, 23, 12. [CrossRef] [PubMed]
[20] Tamburús, N.Y.; Kunz, V.C.; Salviati, M.R.; Simões, V.C.; Catai, A.M.; Da Silva, E. Interval training based on ventilatory anaerobic threshold improves aerobic functional capacity and metabolic profile: A randomized controlled trial in coronary artery disease patients. Eur. J. Phys. Rehabil Med. 2015, 52, 1–11. [PubMed]
[21] Taylor, R. S., Dalal, H. M., & McDonagh, S. T. J. (2022). The role of cardiac rehabilitation in improving cardiovascular outcomes. *Nature reviews. Cardiology*, *19*(3), 180–194. https://doi.org/10.1038/s41569-021-00611-7
[22] Villelabeitia-Jaureguizar, K.; Vicente-Campos, D.; Senen, A.B.; Jiménez, V.H.; Garrido-Lestache, M.E.B.; Chicharro, J.L. Effects of high-intensity interval versus continuous exercise training on post-exercise heart rate recovery in coronary heart-disease patients. Int. J. Cardiol. 2017, 244, 17–23. [CrossRef]
[23] Warburton, D.E.; McKenzie, D.C.; Haykowsky, M.J.; Taylor, A.; Shoemaker, P.; Ignaszewski, A.P.; Chan, S.Y. Effectiveness of High-Intensity Interval Training for the Rehabilitation of Patients with Coronary Artery Disease. Am. J. Cardiol. 2005, 95, 1080–1084. [CrossRef]
[24] Wisloff, U.; Stoylen, A.; Loennechen, J.P.; Bruvold, M.; Rognmo, Ø.; Haram, P.M.; Tjonna, A.E.; Stig, J.H.; Slørdahl, S.A.; Lee, S.J.; et al. Superior cardiovascular effect of aerobic interval training versus moderate continuous training in heart failure patients: A randomized study. Circulation 2007, 115, 3086–3094. [CrossRef] [PubMed]