



## Review Article

## Phase I Cardiac Rehabilitation Intervention in Patients Undergoing Coronary Artery Bypass Grafting

Ardhani Galih<sup>1\*</sup>, Cholid Tri Tjahjono<sup>2</sup>, Ardian Rizal<sup>2</sup>, Heny Martini<sup>2</sup>,<sup>1</sup>Brawijaya Cardiovascular Research Center, Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia.<sup>2</sup>Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia.

## ARTICLE INFO

## Keywords:

Cardiac Rehabilitation Phase I;  
Coronary Artery Bypass Grafting.

## ABSTRACT

Patients undergoing coronary artery bypass grafting (CABG) have a risk of postoperative complications that result in prolonged hospitalization and even death. Interventions in the form of phase I cardiac rehabilitation are needed to help speed up the postoperative recovery process and prevent complications after CABG. Although a lot of research has been carried out, it is necessary to conduct further studies of research articles regarding interventions that can be carried out in cardiac rehabilitation programs that are safe and easy to perform in postoperative CABG patients. The purpose of this literature review was to examine safe and effective interventions in phase I cardiac rehabilitation in patients undergoing CABG. The implementation of phase I cardiac rehabilitation in patients undergoing CABG started from the preoperative phase and continued postoperatively until the patient was discharged. Phase I cardiac rehabilitation interventions, both pre and postoperative, consist of education and counselling, physical exercise, breathing exercises, effective coughing exercises, inspiratory muscle training, and chest physiotherapy. The results of this literature review can be used as a basis for determining standard operating procedures for the implementation of phase I cardiac rehabilitation for hospitals that provide CABG services.

### 1. Introduction

Cardiovascular diseases (CVDs) are the leading cause of death globally. An estimated 17.9 million people died from CVDs in 2019, representing 32% of all global deaths. Of these deaths, 85% were due to heart attack and stroke. Over three quarters of CVD deaths take place in low- and middle-income countries, including Indonesia. Out of the 17 million premature deaths (under the age of 70) due to noncommunicable diseases in 2019, 38% were caused by CVDs.<sup>1</sup> Given the growing number of deaths from Coronary Heart Disease (CHD), it is critical to provide effective management. One of these is through performing revascularization intervention called Coronary Artery Bypass Grafting (CABG).

Coronary Artery Bypass Grafting (CABG) is a treatment for CHD patients that uses blood vessels taken from other parts of the body and cuts or "bypasses" blocked or narrowed coronary arteries.<sup>2</sup> The purpose of CABG is to reduce angina, reduce the risk of recurrent attacks, help prolong life expectancy, optimize heart function, and improve quality of life. In addition to having a positive impact on the condition of CHD patients, patients undergoing CABG is also at risk for postoperative complications that can affect outcomes including length of stay and increased postoperative mortality.

Research conducted by Soares, et al. stated that 58% of postoperative cardiac patients experience complications such as the pulmonary system (31%), the cardiovascular system (15.8%), and the nervous system (13.9%). Complications that occur include infection, bleeding, heart attack, decreased heart function, phrenic nerve paralysis, and disorders of the respiratory system such as atelectasis, pneumonia, pulmonary oedema, haemothorax, and bronchospasm.<sup>3</sup>

Patients undergoing CABG are not only at risk for operative-related complications but also experience physical and psychological problems such as pain, decreased heart muscle strength, anxiety, stress, depression, changes in response to spirituality that can affect the patient's quality of life and even experience depression that increase risk of death.<sup>4,5</sup> Therefore, it is necessary to intervene for prevent and reduce these problems, as well as to help speed up the recovery process after CABG surgery. Interventions that can be done are cardiac rehabilitation programs. Cardiac rehabilitation is a program that combines several interventions, either physical, psychological, or educational. This program aims to optimize both physical and psychological, also social functions so that it is expected to reduce morbidity and mortality, as well as improve the quality of life of CHD patients.<sup>6</sup>

\*Corresponding author at: Brawijaya Cardiovascular Research Center, Department of Cardiology and Vascular Medicine, Faculty of Medicine, Universitas Brawijaya, Malang, Indonesia  
E-mail address: [rarkyanpanji@gmail.com](mailto:rarkyanpanji@gmail.com) (A. Galih).

<https://doi.org/10.21776/ub.hsj.2022.003.04.2>

Received 9 July 2022; Received in revised form 30 August 2022; Accepted 15 September 2022

Available online 1 October 2022

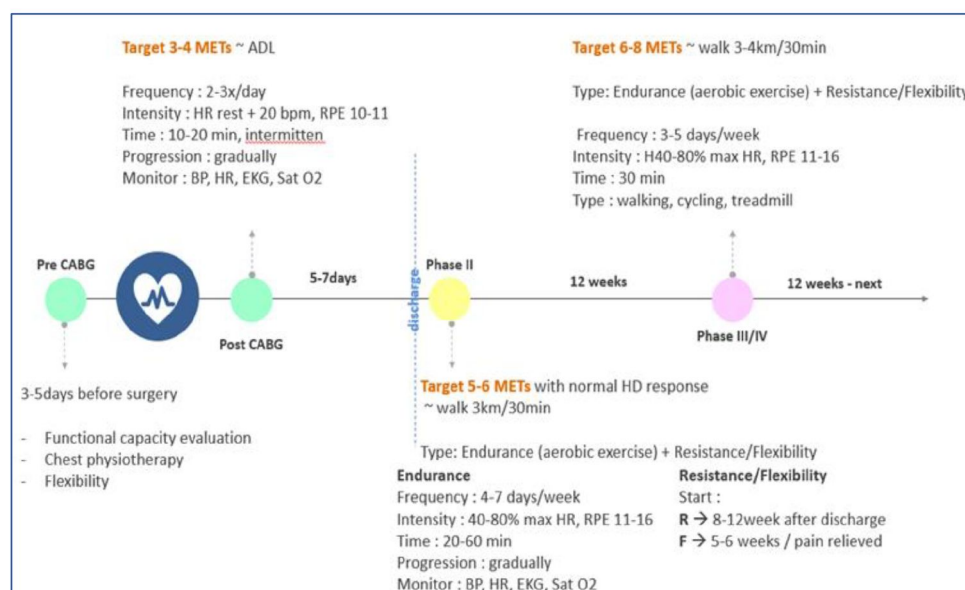


Figure 1. The timeline exercise-based rehabilitation phase in patient undergoing CABG. Phase I is carried out during the hospitalization. A mix of physical activity of moderate intensity and stress control strategies and risk factors education is performed to ensure that the patient is discharged in the best psychological and physical state.<sup>11</sup>

Cardiac rehabilitation consists of three phases and all phases of cardiac rehabilitation are important in patients undergoing CABG surgery. This cardiac rehabilitation program starts from phase I in patients undergoing heart surgery starting preoperatively and continuing postoperatively. Phase I cardiac rehabilitation is cardiac rehabilitation that is carried out in hospital until they are discharged by performing mobilization, physical and respiratory activities, providing education regarding risk factors for heart disease, as well as stress and anxiety management.<sup>7</sup>

Several studies on phase I cardiac rehabilitation stated that patients undergoing the program showed an increase blood oxygen circulation in the body, as well as functional capacity.<sup>8-9</sup> Systematic reviews also stated that early mobilization after cardiac surgery has a positive impact such as length of stay, functional capacity, and prevention of postoperative complications.<sup>10</sup>

Phase I cardiac rehabilitation interventions in patients undergoing CABG surgery differ from those in patients undergoing percutaneous coronary intervention or fibrinolytic therapy. This happens because CABG surgery is a major surgical intervention with a long duration and has a higher risk of complications than other methods.<sup>12</sup> Cardiac rehabilitation intervention in patients undergoing CABG surgery already performed in all hospital, although the protocol still vary depending on the policies of each hospital. The research conducted by Cassina et al stated that early postoperative mobilization interventions are safe to do as long as the patient's hemodynamic status is stable and monitoring is still carried out during the intervention.<sup>13</sup>

Although cardiac rehabilitation interventions are safe for CABG patients, the method of intervention in phase I cardiac rehabilitation programs is still varies. Integrating several interventions included in a phase I cardiac rehabilitation program will have a positive impact on outcomes, especially those undergoing CABG surgery. Therefore, we are interested in conducting a literature review regarding any interventions that can be performed in phase I cardiac rehabilitation that are safe and easy to perform in postoperative CABG patients.

## 2. Discussion

In general, the intervention in the phase I cardiac rehabilitation program in patients undergoing CABG surgery is divided into two groups, namely preoperative and postoperative.

### 2.1 Preoperative Cardiac Rehabilitation Intervention.

Phase I cardiac rehabilitation interventions that can be performed preoperatively include education, breathing exercises, breathing exercises with inspiratory muscle training, psychological counselling, effective coughing exercises, and physical exercises.<sup>11</sup>

### 2.2 Education.

The education provided in the preoperative phase includes provide information about the activities that will be carried out when the patient has finished undergoing surgery, the care that will be carried out postoperatively, as well as information about diet, nutrition, drugs that will be used for urinary catheter care and drainage tubes, and how to change positions and physical activities to be carried out postoperatively.<sup>14-15</sup> Patients who are given preoperative education can reduce anxiety and increase the functional capacity of postoperative CABG patients.<sup>15</sup>

### 2.3 Breathing Exercises.

Breathing exercise is the key process in the preoperative preparation. Abdominal breathing exercises, purse lip, and deep breathing are recommended for patients undergoing CABG surgery. This is supported by Shakuri, et al. regarding giving breathing exercises including abdominal, purse lip breathing and deep breathing can improve postoperative respiratory function.<sup>16</sup> A similar study was also conducted by Sobrinho et al, who provided preoperative physiotherapy interventions in the form of breathing exercises consisting of deep breathing, then exhalation and long inspiration, breathing using the diaphragm and combined with mobilization of lower extremities,

as well as breathing exercises with a threshold-inspirational muscle trainer.<sup>17</sup> The conclusion of this study is that the exercise given preoperatively can increase the maximum inspiratory and expiratory pressure, so that the patient is better prepared to undergo the recovery process for respiratory function and reduce the length of stay which has an impact on more effective treatment costs. Another study examining the effects of a pulmonary rehabilitation (PR) program applied to patients undergoing coronary artery bypass grafting (CABG) surgery with open heart technique on respiratory functions, functional capacity, and quality of life (QoL), showed the mean FVC and FEV1 values of the patients in the intervention group on the 4th day of clinical care were significantly higher with a medium level size effect than the control group ( $p = 0.027$ ; effect size ( $d$ ) = 0.643;  $p < 0.024$ ; effect size ( $d$ ) = 0.658, respectively).<sup>18</sup>

#### 2.4 Psychological counselling.

Preoperative anxiety is linked to uncertainty and a lack of information. Increased preoperative anxiety has been linked to postoperative problems in coronary artery bypass graft (CABG) patients, including atrial fibrillation, myocardial infarction, higher readmission rates, increased healthcare use, and higher mortality rates. Giving patients beforehand information or instruction is a strategy to reduce preoperative anxiety.



(A)



(B)

Figure 2. Effective cough exercise. (A) Instruct patient to hold pillow firmly over chest/incision; (B). Encourage patient to splint with pillow during coughing.<sup>20</sup>

#### 2.6 Physical exercise.

Physical exercises performed preoperatively include mobilization, muscle stretching exercises and muscle strength training that can improve respiratory function and increase respiratory muscle strength. This is proven by the several research which stated that patients who were given physical exercise preoperatively and then continued postoperatively could improve respiratory function, functional capacity, and accelerate extubation.<sup>16,21</sup>

#### 2.7 Postoperative Cardiac Rehabilitation Intervention.

Phase I cardiac rehabilitation interventions after surgery include physical exercise, breathing exercises, effective coughing exercises, and education.

Preoperative education includes giving patients pertinent information about the procedure and the recovery period (e.g., via a pamphlet, video, audiotape, or discussion). Healthcare workers work to reduce patients' worries, anxieties, and uncertainties by helping them understand the surgical procedure. In individualized or group sessions, educational content includes details about anticipated feelings (like fear), anticipated sensations (like pain), and likely outcomes. This might aid in minimizing the disparity between anticipated and actual feelings or occurrences. Patients may find it easier to deal with discomfort if they understand that it is a typical aspect of surgery and not a sign that something went wrong.<sup>19</sup>

#### 2.5 Effective Cough exercises.

Effective coughing exercises is very important for patients undergoing CABG, because during surgery the patient has an endotracheal tube attached which can trigger secretions in the respiratory tract.<sup>15</sup> This exercise encourages expectoration of mucus and secretions that accumulate in the airways after general anaesthesia and immobility. Effective coughing exercises is one of the techniques in pulmonary care that is safe to use in CABG patients. Performing these exercises every 2 to 3 hours will facilitate pulmonary ventilation and promote airway clearance without overtiring the patients.<sup>20</sup>

#### 2.8 Physical training.

Several articles state that postoperative physical exercise has a positive impact in reducing the occurrence of postoperative complications. Physical exercises performed in postoperative phase I cardiac rehabilitation include mobilization, range of motion (ROM), upper and lower extremity active exercises, and transfer exercises. The exercise is carried out gradually according to the patient's condition. In Iran, Moradian et al conducted a study by providing physical exercise in the form of early mobilization gradually starting 2 hours after extubation. The results of the study stated that the patients with the intervention had a better oxygenation status and the occurrence of complications (atelectasis and pleural effusion) was less than in the non-intervention group.<sup>22</sup>

## 2.9 Breathing exercises.

Breathing exercises performed postoperatively immediately after the patient is extubated can help to reduce chest pain and increase lung functional capacity.<sup>23</sup>

## 2.10 Cough exercises are effective.

Coughing exercises are effective on the first postoperative day (after extubation) to help remove secretions/phlegm in the respiratory tract. Increase tracheal secretion along with ineffective cough can lead to mucus stasis and even respiratory tract infection and extubation failure. Effective coughing can reduce this risk.<sup>14</sup>

## 2.11 Education.

The education provided after CABG surgery includes heart anatomy, disease, acute coronary syndrome, signs and symptoms of heart disease and modification of risk factors as well as providing re-information about pain management, controlling blood pressure and pulse rate, diet, and determine the next activity to be done at home.<sup>19,24</sup>

## 3. Additional Interventions

Additional interventions that can be performed on patients undergoing phase I cardiac rehabilitation program include respiratory muscle stretch gymnastics (RMSG) and increased exercise intensity that can improve outcomes after CABG surgery. This is evidenced by the study of Modi et al which compared postoperative patients undergoing phase I cardiac rehabilitation only with patients undergoing cardiac rehabilitation plus moderate intensity exercise on the results of the distance of 6MWT and quality of life. The results of the study indicated that moderate intensity exercise can improve outcomes, namely the 6MWT test results and quality of life so that it can accelerate the cardiac rehabilitation process and shorten the length of stay.<sup>25</sup> Subsequent research provides additional interventions in the phase I cardiac rehabilitation program in the form of respiratory muscle stretch gymnastics (RMSG) which is carried out on days 3-7 after CABG surgery. RMSG is a stretching exercise technique that is performed sequentially to stretch the muscles involved in breathing which consists of 5 exercise patterns. The exercise pattern consists of shoulder elevation, slowly stretching the upper chest, back and lower chest muscles, and elbow elevation. The conclusion of this study is that the addition of RMSG in cardiac rehabilitation can help reduce pain in both the scapula muscle and postoperative CPC pain.<sup>26</sup>

## 4. Time and Duration of Phase I Cardiac Rehabilitation

Preoperative phase I cardiac rehabilitation in the form of providing education regarding lung care techniques including abdominal breathing and effective coughing, postoperative actions that will include mobilization, drainage treatment, and urinary catheters, as well as psychological counselling started when the patient was admitted to the hospital or 2-3 days before surgery.<sup>15</sup> Physical exercise starting 2-3 days preoperatively and then continued for 5 days postoperatively can accelerate the recovery of respiratory muscle strength, increase functional capacity, quality of life, and psychosocial status of the patient.<sup>21</sup> The duration of breathing exercises and breathing exercises with a threshold-inspiratory muscle trainer is carried out 3-10 times for 2-30 minutes.<sup>16,17,21</sup>

Postoperative phase I cardiac rehabilitation begins on the first postoperative day or after extubation until the fifth

postoperative day.<sup>22</sup> The duration of cardiac rehabilitation depends on the type of exercise such as breathing muscle exercises performed for 30 minutes, gradual mobilization includes repositioning from supination to sitting, from sitting to standing, from standing to walking 2 times a day. Walking exercises are carried out for about 1-45 minutes gradually according to the patient's ability.<sup>14,21,27</sup>

## 5. Conclusion

Cardiac rehabilitation interventions in patients undergoing CABG surgery are generally divided into two, namely interventions that start from preoperative and continue postoperatively until the patient returns home. Interventions both preoperatively and postoperatively consisted of education and counselling, physical exercise, breathing exercises, effective coughing, inspiratory muscle training, chest physiotherapy, and respiratory muscle stretch gymnastics. When these interventions are combined in a program, namely cardiac rehabilitation phase I, it is expected to improve outcomes optimally which has an impact on improving the patient's quality of life. The results of this literature review can be used as a basis for determining standard operating procedures for the implementation of phase I cardiac rehabilitation for hospitals that provide CABG services.

## 6. Declarations

6.1. *Ethics Approval and Consent to participate*  
Not applicable.

6.2. *Consent for publication*  
Not applicable.

6.3. *Availability of data and materials*  
Data used in our study were presented in the main text.

6.4. *Competing interests*  
Not applicable.

6.5. *Funding source*  
Not applicable.

6.6. *Authors contributions*  
Idea/concept: AG, CT. Design: AG, CT. Control/supervision: CT, AR, HM. Data collection/processing: DAI. Analysis/interpretation: AG, CT, AR, HM. Literature review: CT, AR, HM. Writing the article: DAI. Critical review: CT, AR, HM. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

10.7 *Acknowledgements*  
We thank to Brawijaya Cardiovascular Research Center.

## References

1. World Health Organization. (2021). Cardiovascular Disease. Retrieved from <https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-cvds>
2. Bachar BJ, Manna B. Coronary Artery Bypass Graft. [Updated 2022 May 19]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan-. Retrieved from: <https://www.ncbi.nlm.nih.gov/books/NBK507836/>.
3. Soares, G., Ferreira, D., Gonçalves, M., Alves, T., David, F., Henriques, K., & Riani, L. (2011). Prevalence of major postoperative complications in cardiac surgery. *International Journal of Cardiovascular Sciences*, 24 (3), 139-146.

4. Leung, Y.W., Flora, D.B., Gravely, S., Irvine, J., Carney, R.M., & Grace, S.L. (2015). The impact of pre-morbid and post-morbid depression onset on mortality and cardiac morbidity among coronary heart disease patients: A meta-analysis. *Psychosomatic Medicine*, 74 (8), 786–801
5. Nuraeni, A., Mirwanti, R., Anna, A., Prawesti, A., & Emaliyawati, E. (2016). Faktor yang memengaruhi kualitas hidup pasien dengan penyakit jantung koroner factors influenced the quality of life among patients diagnosed with coronary heart disease. *Jurnal Keperawatan Padjadjaran*, 4 (2), 107–116.
6. Contractor, A.S. (2011). Cardiac rehabilitation after myocardial infarction. *Journal of the Association of Physicians of India*, 59, 51–55.
7. Winkelmann, E.R., Dallazen, F., Beerbaum, A., Bronzatti, S., Lorenzoni, C.W., & Windmöller, P. (2015). Analysis of steps adapted protocol in cardiac rehabilitation in the hospital phase. *Brazilian Journal of Cardiovascular Surgery*, 30 (1), 40–48. doi.org/10.5935/1678-9741.20140048
8. Ghashghaei, F.E., Sadeghi, M., Marandi, S.M., & Ghashghaei, S.E. (2012). Exercise-based cardiac rehabilitation improves hemodynamic responses after coronary artery bypass graft surgery. *ARYA Atherosclerosis*, 7 (4), 151–156.
9. Parvand, M., Goosheh, B., & Sarmadi, A.R. (2016). Effect of cardiac rehabilitation on heart rate and functional capacity in patients after myocardial infarction. *Iranian Rehabilitation Journal*, 14 (3), 157–162. doi.org/10.18869/nrip.irj.14.3.157
10. Santos, R.D., Ricci, A., Suster, A.B., Paisani, D.M., & Chiavegato, D.L. (2016). Effects of early mobilisation in patients after cardiac surgery: a systematic review. *Physiotherapy (United Kingdom)*, 103 (1), 1–12. doi.org/10.1016/j.physio.2016.08.003.
11. Dewi, I.P., Dewi, K.P., Tanojo, T., Mulia, E.P.B. and Adriana, M., 2021. Pearls of exercise-based cardiac rehabilitation frame in post coronary artery bypass graft. *Anaesthesia, Pain & Intensive Care*, 25(3), pp.367-375..
12. Alexander, J.H., & Smith, P.K. (2016). Coronary artery bypass grafting. *New England Journal of Medicine*, 374 (20), 1954–1964. doi.org/10.1056/NEJMr1406944.
13. Cassina, T., Putzu, A., Santambrogio, L., Villa, M., & Licker, M.J. (2016). Hemodynamic challenge to early mobilization after cardiac surgery : A pilot study. *Annals of cardiac anaesthesia*, 19 (3), 425–432. doi.org/ 10.4103/0971-9784.185524.
14. Dong, Z., Yu, B., Zhang, Q., Pei, H., Xing, J., Fang, W., ... Song, Z. (2016). Early rehabilitation therapy is beneficial for patients with prolonged mechanical ventilation after coronary artery bypass surgery. *International Heart Journal*, 57 (2), 241–246. doi.org/10.1536/ihj.15-316.
15. Zhang, C.Y., Jiang, Y., Yin, Q.Y., Chen, F.J., Ma, L. Le, & Wang, L.X. (2012). Impact of nurse-initiated preoperative education on postoperative anxiety symptoms and complications after coronary artery bypass grafting. *Journal of Cardiovascular Nursing*, 27 (1), 84–88. doi.org/10.1097/JCN.0b013e3182189c4d.
16. Shakuri, S.K., Salekzamani, Y., Taghizadieh, A., Sabbagh-Jadid, H., Soleymani, J., Sahebi, L., & Sahebi, R. (2015). Effect of respiratory rehabilitation before open cardiac surgery on respiratory function: a randomized clinical trial. *Journal of Cardiovascular and Thoracic Research*, 7 (1), 13–17. doi.org/10.151 71/jcvtr.2014.03.
17. Sobrinho, M.T., Guirado, G.N., & Silva, M.A.D.M. (2014). Preoperative therapy restores ventilatory parameters and reduces length of stay in patients undergoing myocardial revascularization. *Brazilian Journal of Cardiovascular Surgery*, 29(2), 221–228. doi.org/10.5935/1678-9741. 20140021.
18. Girgin, Z., Cigerci, Y., & Yaman, F. (2021). The Effect of Pulmonary Rehabilitation on Respiratory Functions, and the Quality of Life, following Coronary Artery Bypass Grafting: A Randomised Controlled Study. *BioMed research international*, 2021, 6811373. doi.org/10.1155/2021/6811373
19. Salzmänn, S., Salzmänn-Djufri, M., Wilhelm, M., & Euteneuer, F. (2020). Psychological Preparation for Cardiac Surgery. *Current cardiology reports*, 22(12), 172. doi.org/10.1007/s11886-020-01424-9
20. Craven and Hirnle's Nursing Fundamentals and Procedures Online. Retrieved from [https://downloads.lww.com/wolterskluwer\\_vitalstream\\_com/sam-ple-content/9780781788786\\_craven/samples/mod09/topic5b/text.html](https://downloads.lww.com/wolterskluwer_vitalstream_com/sam-ple-content/9780781788786_craven/samples/mod09/topic5b/text.html)
21. Savci, S., Degirmenci, B., Saglam, M., Arikan, H., Inal-Ince, D., Turan, H.N., & Demircin, M. (2011). Short-term effects of inspiratory muscle training in coronary artery bypass graft surgery: A randomized controlled trial. *Scandinavian Cardiovascular Journal*, 45(5), 286–293. doi.org/10.3109/14017431. 2011.595820.
22. Moradian, S.T., Najafloo, M., Mahmoudi, H., & Ghiasi, M.S. (2017). Early mobilization reduces the atelectasis and pleural effusion in patients undergoing coronary artery bypass graft surgery: A randomized clinical trial. *Journal of Vascular Nursing*, 35 (3), 141–145. doi.org/10.1016/j.jvn.2017.02. 001.
23. Stein, R., Maia, C.P., Silveira, A.D., Chiappa, G.R., Myers, J., & Ribeiro, J.P. (2009). Inspiratory muscle strength as a determinant of functional capacity early after coronary artery bypass graft surgery. *Archives of Physical Medicine and Rehabilitation*, 90 (10), 1685–1691. doi.org/10.1016/j. apmr.2009.05.010.
24. Borzou, S.R., Amiri, S., Salavati, M., Soltanian, R., & Safarpour, G. (2018). Effects of the first phase of cardiac rehabilitation training on self-efficacy among patients undergoing coronary artery bypass graft surgery. *The Journal of Tehran University Heart Center*, 13 (3), 126–131.
25. Modi, R., Bhise, A., & Patel, F. (2014). Effect of supervised moderate intensity exercise program in phase one cardiac rehabilitation of post operative CABG patients - a randomized controlled trail. *International Journal of Physiotherapy*, 1 (4), 215–219. doi.org/10.15621/ijphy/2014/v1i4/54561.
26. Akhtar, S.A., Ahmed, F., Grover, S., & Srivastava, S. (2015). Effect of respiratory muscle stretch gymnastics on pain, chest expansion, pulmonary functions and functional capacity in phase 1 post-operative CABG patients. *Journal of Cardiology & Current Research*, 2 (6), 1–5. doi.org/10.15406/jccr.2015. 02.00084.
27. Kloppe, M., & Hanekom, S. (2014). The implementation of an intensity regulated exercise programme in coronary artery bypass graft surgery patients : A pilot randomised controlled trial. *SA Heart*, 11 (3), 136–142. doi.org/10.24170/11-3-1750.