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Faculty of Psychology and Science of Education

DOCTORAL THESIS SUMMARY

**Psychosocial Variables in Personalized
Rehabilitation Programs for Patients Suffering of
Coronary Heart Disease**

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Introduction

Key words: psychosocial variables; cardiac rehabilitation program (CRP); coronary heart disease (CHD); myocardial infarction (MI)

This study examines a cardiac rehabilitation program (CRP) based on physical fitness/strength training for improvement in psychosocial and physical measures of cardiac patients following a cardiac event.

The aims of the study were to evaluate the importance of the effect of physical exercise-based strength training, including isometric strength, on the improvement in fitness levels and psycho-social variables amongst both men and women cardiac patients following a cardiac event. As such, it also examines the suitability of the program to be used as a predictor of the success of cardiac rehabilitation programs for patients following a cardiac event.

These critically important indicators (psychosocial and physical variables) constitute risk factors for morbidity and mortality in the coronary heart disease (CHD) epidemic, thus relating to public health in general and saving lives in particular (Matushita et al, 2010).

The indicators are also important for the following practical reasons: achieving the goals of cardiac rehabilitation programs through the optimization of the program; the return of cardiac patients to a healthy, creative, and high-quality lifestyle; preventing the disease's advance and encouraging the regression of the plaque process in CHD patients; reducing the risks of cardiac events such as sudden death, recurring infarction and unstable angina; and decreasing the need for invasive interventions. Achieving these goals may have far-reaching implications for the future of health policies, including health indicator planning and intervention on the national and even international levels.

Despite the importance of this issue, to date it has been paid too little scientific attention (Pollock et al, 2000; Hambrecht et al, 2000b; Strohle, 2009). The scientific literature lacks systematical information regarding the effect of physical exercise based on strength training in general, and isometric strength in particular, on cardiac patients following a cardiac event, and in predicting the success of such training as

part of a long-term intervention. On this basis, experts have proposed (Pollock et al, 2000; Strohle, 2009; Hambrecht et al, 2000b) examining these approaches to improving physical and psycho-social variables, and even updating existing clinical recommendations (clinical guidelines) for cardiac rehabilitation programs.

In this study, two key aspects were examined that may shed light on the need to expand, improve, and add to the existing physical exercise program based on endurance training, strength training and especially isometric training and they are: the physical/physiological aspect and the psycho-social aspect.

In light of the assumption that strength-based physical exercise affects the physical and physiological improvement in the general population (Scheinowitz, 2000; Strohle 2009), we decided to evaluate this also amongst cardiac patients following a cardiac event. We thought that because rehabilitation patients suffer from a physical disadvantage and are characterized by poor physical condition and a difficult mental state, it would be correct to examine separately the suitability of the strength training program to be used as a predictor of the success of improvement in psychosocial and physical state.

Two main questions were the focus of the study. The first is whether there is a need for strength-based training programs in order for cardiac patients to improve their physical conditions. The second is whether there is a need for strength training in order for cardiac patients to improve their psycho-social variables.

1. Psychosocial Aspects and variables among CHD Patients

1.1 Epidemiological Aspects

CHD is still the single largest cause of death and disability in Western civilization. Victims of these diseases and their families greatly suffer, both physically and mentally (Lopez et al, 2006).

In the United States alone there are more than 14 million CHD patients. Every year, 1.5 million individuals develop acute myocardial infarction (AMI), the most deadly presentation of CHD, and more than 500,000 of these individuals die. The prognosis of myocardial infarction (MI) survivors remains poor, demonstrating a risk of mortality and morbidity 1.5-15 times greater than that of the rest of the population. (McPherson,2010).

For primary atherosclerotic heart disease (“clogged” coronary arteries), which may cause angina pectoris, MI and sudden cardiac death, the common medical treatments comprise a wide range of medications, percutaneous coronary intervention (e.g., percutaneous trans luminal coronary angioplasty-PTCA), thrombolytic therapy, coronary artery bypass graft (CABG) surgery, and for those with potentially lethal arrhythmias, placement of an implantable cardioverter defibrillator. All those treatments, which may last many years, carry a tremendous financial cost.

Although men and women from all backgrounds are affected, it is well established that psychosocial and behavioral risk factors greatly predict who will develop the disease (Dyer & Beck, 2007; Day, 2001).

On the contrary of physiological risk factors, the study and clinical treatments of psychosocial factors for CHD patients have been somewhat neglected.

Compelling data have linked depression, (the risk factor with the most compelling database), social isolation, stress, anger, anxiety and a several other psychosocial factors with both the onset of CHD, and its effects (Dimsdale, 2008).

Symptoms of depression and anxiety are very common among cardiac patients, (Jordan, Bardé, & Zeiher, 2007). Sometimes, the attending physician, the patient and those around him believe that the development of depression and anxiety disorders symptoms due to a deficient heart is natural, even expected process.

Depression is a significant risk factor for developing CHD and increased morbidity and mortality after a sharp cardiac event.

Research-based evidence has long suggested that anxiety and depression predict morbidity and death from CHD, even after controlling for biological risk factors such as serum cholesterol and blood pressure (Dyer & Beck, 2007).

The connection of depression, anxiety, hostility and other psychological variables to CHD, questioning where the mechanisms and processes of bio - psycho – social channel the development and integration of optimal therapeutic approaches.

1.2 Psychobiological Aspects

The development of biological psychiatry points to a series of neuro - chemical, neuro

– endocrine, and neuro – anatomy disorders pertaining to depression (Nahshoni & Weizman, 2005). Some of those may provide an etiopathological explanation for the development of CHD resulting from depression.

- Hyperactivity –Hypothalamus - Hypophysis - adrenal axis (HPA)
- Decrease in heart rate variability (variance reduction)
- Myocardial Instability and Ischemia as a response to mental stress
- Platelet activity disorders
- Immune system disorders

Hyperactivity –in Hypothalamus - Hypophysis - Adrenal Axis (HPA)

The explanation of fight-or-flight responses consists of two main components (Emergency - escape theory of Walter Cannon version - fight or flight response):

1. HPA-axis (hypothalamus - hypophysis - adrenal)
2. Sympathetic – adrenal system.

1. In response to stress, neurons in the hypothalamus, which contain and secrete Corticotropin Releasing Factor (CRF), interrupt the production secretion of Adrenocorticotrophic Hormone (ACTH), Beta Endorphin, and the emission of products of Proopiomelanocortin (POMC) from the front hypophysis.

In Major Depression, the HPA axis is the most active. High CRF levels are found in the cerebrospinal fluid,(CSF) , thereby reducing ACTH response in providing CRF, also resulting in the failure of Cortisol secretion suppression, as well as in providing Dexamethasone. Plus, the activity of hypophysis adrenal glands increases, as does the number of hypothalamus neurons containing CRF.

Administering a treatment of corticosteroids balances Hyperlipidemia and hypertension, as well as steroids related injuries in vascular endothelial, intima, and promotes normal recovery. Findings have confirmed that morning high levels of cortisol are significantly correlated with a severe coronary disease among young and middle aged men.

2. Many patients who suffer Major Depression also demonstrate a dysfunction of the sympathetic – adrenal system, which consists of the adrenal medulla and sympathetic nervous system. The hypothalamus neurons, which contain CRF, stimulate autonomic centers associated with the sympathetic nervous activity, which are related to control and release of catecholamines. Stimulation of this system occurs during physical

exertion/exercise, Coronary Ischemia, and mental stress.

In Major Depression, an increase in norepinephrine in the plasma was discovered. Its level was found to be very high, especially in a state of melancholy. The Hypersympathetic – adrenal plays a role in developing a cardiovascular disease risk, because of its effects on the heart, blood vessels and platelets.

Decrease in Heart Rate Variability (HRV)

A reduction in the HRV indicates a disorder related to the autonomic nervous system, (ANS), raising another prospective explanation about the low survival rate of patients suffering a Major Depression. The source of this hypothesis is the cardiology field. In the 80's, it was found that a decrease in HRV upon a MI constitutes a factor in increased mortality prognosis. In other words, a reduction of the Vagal control, and meanwhile, an increase of sympathetic nervous control, lowers the threshold for the appearance of fatal (lethal) arrhythmias (Nahshoni & Weizman , 2005).

This finding was also confirmed in animal experiments. Since depression involves an increased mortality rate, the hypothesis of autonomic activity disorder may enhance the understanding of increased cardiac mortality etiopathology of depression among people who suffer no heart diseases.

Measuring the HRV in patients with Major Depression, found a decrease in the HRV (Balogh, Fitzpatrick, Hendricks, & Paige, 1993).

Findings(Glassman, 2005)

clearly indicate a cardiac autonomic imbalance. Hence, the etiopathology of an increased cardiac mortality MDD patients ((Major Depressive Disorder), is apparently connected to low vagal activity, which, in turn, lowers the threshold for fatal arrhythmia. Additionally, for patients with a coronary disease who also suffer depression, the HRV is significantly lower than for patients suffering a coronary disease, but not depression.

Myocardial Ischemia and Ventricular Instability Under Mental Stress

There is impact of mental stress on myocardial Ischemia. Mental Stress was found to be significantly related to myocardial events (both fatal and non-fatal), regardless of

age, ejection fraction (EF) and an acute MI. (Nahshoni & Weizman , 2005). It is hypothesized that psychological stress lowers the threshold for ventricular fibrillation, which the arrhythmia constitutes the most common cause of death among CHD patients. In this case, too, the hypothesis is related to vagal activity (Excessive vagal nerve activity, which slows the heart rate and lowers blood pressure, which results in fainting. Possible reasons are: pain, stress, shock or anxiety) , an anti – arrhythmia effect, and increase in ectopic ventricular activity due to mental stress, hence the increased risk of ventricular fibrillation. For patients with CHD, mental stress reduces heart mobility and the injection fraction of the left ventricular (LVIF), ischemia was a consequence of mental stress, which is painless for 83% of patients demonstrating an impaired heart contraction disorder, and appeared in lower heart rates than ischemia due to physical effort. A speech containing emotional elements increases heart contraction disorders more than a cognitive effort which causes mental stress without an emotional component. The impact strength of heart muscle contraction as a result of speech was similar to that of physical exertion. Research which examined changes in ST segments Holter monitor records of CHD patients, found that among those whom have experienced mental stress, there were more events of "silent" ischemia- painless- (Nahshoni & Weizman , 2005). Frasure-Smith et al (1998) argue that depression prognosis becomes poorer after MI, using a different mechanism – early ventricular beats (VPBs - Ventricular Premature Beats). They found that the risk of sudden death, which was related to depression, was at its highest among patients whose measurement was ten or more VPBs per hour; 60% of these patients died within 18 months. This finding suggests a possible role of arrhythmia as the link connecting depressive symptomatology and sudden death. Among post MI patients and VPBs, who were not depressed, the mortality rate was low even when the injection fraction of the left ventricular was low. Therefore, it is reasonable that the Prognostic value of VPBs may be related more to depression than their VPBs.

Depression and CHD

A possible consequence of depression on CHD may also be blood platelet-related mechanisms. The increased platelet response due to mental stress may activate an

ischemic event. Results of studies linking CVA (Cerebrovascular Accident) to depression indirectly support the relationship between depression and CHD.

Subjects who suffered depression, the mortality risk was 3.4 times higher for the following 10 years, compared to those who did not suffer depression.

The question that is being raised is, does depression in physically healthy person may be a risk factor for mortality due to vascular causes?

It was found (Musselman et al, 2000) that the platelet for people suffering major depression without physical diseases is activated, and demonstrates a higher reactivity than among healthy subjects. Moreover, the comparison between cardiac patients with depression and cardiac patients who do not suffer depression discovered significantly high levels of Platelet factor 4 (PF4) and beta thromboglobulin (Beta-TG) among the group of depression patients. Serotonin secreted by platelets increases the platelet aggregation and vascular contraction - through the kind of 5HT₂ receptors (Serotonin 5-Hydroxytryptamine₂). In recent years, the accumulated evidence supports the hypothesis about serotonergic function disorders, both central nervous system and platelets. Although activation of platelets by serotonin is relatively weak, it is greatly increased platelet response to other agonists - ADP, Thromboxane A₂ (TXA₂), Catecholamines and Thrombin.

Several studies (Sauer, Berlin, Kimmel, 2003) have reported an increase in Link density to 5HT₂ in platelet of patients suffering depression. It was found that this condition is reversible and returns to normal with an improvement in the depression condition (!!).

In depression, a significant decrease in serotonin carrier sites is demonstrated, both in the central nervous system and in the platelets (Both here and here). This combination effectively reduces the uptake of serotonin and reveals the high numbers of 5HT₂ serotonin receptors outside the platelets. In addition, in the platelets of depressed patients, there are elevated levels of free calcium following serotonergy stimulation. Even on low free calcium increases in platelets amplifies the response of platelets to weak agonists (such as serotonin) or even leading to an increase in the bloodstream.

Depression and Immune System

For various states of depression, there were found evidence (Nahshoni, Weizman,

2005; Maes, Scharpe, Meltzer, Bosmans, Suy, Calabrese, & Cosyns, 1993), of disturbance in the immune system regulation (Immune regulation disorder). For example, evidence indicating an increase of inflammation markers (white blood cells-Leucocyte, C-reactive protein, various cytokines and changes in the relative distribution of B cells and T). These findings suggest that the two arms of the immune system are activated; Humoral/serum response and cells response. These processes may be linked to the other findings concerning disorders in the metabolism of fatty acids under a depression condition. For example, the lack of unsaturated fatty acid omega-3, which is characteristic of depression, may lead to an increased production of cytokines, triggering an inflammation. These complex processes may result in a development of CHD, disturbances in HPA-axis and, in turn, an increased risk for arrhythmia. Yet one of the etiopathological indicators of CHD development is sub-chronic inflammatory processes, involving a sharp protein response - (C-Reactive Protein) CRP and cytokines. The rise of these markers can induce a "sickness behavior" a syndrome characterized by a decline of energy, poor appetite and weight loss, sleep disorders, anhedonia - (an inability to enjoy things one normally enjoys) a generally low mood. These signs are part of the diagnosis of depression. Therefore, depression may be a cause or an effect of inflammatory processes which are also part of CHD development process.

Connections between psycho-social factors and heart disease and evidently show bilateral relationship: Psycho-social factors constitute significant risk factors for heart disease in general, and for CHD in particular and the impact of the disease, particularly MI and cardiac arrest on the development of depression and anxiety disorders symptoms and other psychosocial factors, is well clarified.

Prominent aspects of physical activity and CHD

The studies of the cardioprotective effects of exercise training in patients with CHD have yielded results. Exercise training has been associated with improvement in myocardial perfusion and endothelial function in patients with CHD, even in the patients who have progression of coronary atherosclerosis.

(Hambrecht, 2000a)

Coronary vasoconstriction in response to acetylcholine was significantly attenuated after exercise training, indicating that exercise had beneficial effects on the endothelium of epicardial conduit vessels. In agreement with this result was the finding that adenosine induced flow-dependent vasodilatation after training was markedly improved.

In addition, it was also found that exercise training was associated with increases in agonist-mediated blood flow velocity and coronary blood-flow reserve. These findings indicate that in the absence of clinically significant coronary-artery stenosis, the vasodilatory capacity of coronary resistance vessels was enhanced.

However, in this study of Hambrecht, (2000a), a four-week period of high intensity endurance training improved the endothelial response to acetylcholine but did not restore it to normal levels, suggesting that the restoration of normal endothelial function may require a more extended exercise-training intervention. In studies of patients with symptomatic CHD, long-term exercise training was associated with a significant reduction in the incidence and severity of exercise-induced myocardial ischemia. It is reasonable to suppose that in these patients myocardial perfusion was augmented after training.

and emphasizes the therapeutic potential of endurance training for patients with stable CHD.

Regular exercise may represent a non-pharmacological therapeutic option to delay the decrease in endothelial function associated with ageing (Rinder et al. 2000) and reverse impaired endothelial function in individuals with atherosclerosis (Hambrecht et al. 2000b) or HF (Hambrecht et al. 2000a). Exercise increases blood flow to the exercised limbs and myocardium. This increased flow augments shear stress and in the presence of normal endothelial function produces vasodilatation.

Cardiac Rehabilitation programs (CRP)

Cardiac Rehabilitation (CR) services, are now considered an integral part of comprehensive set of treatment in people with heart diseases in general and especially for CHD patients, they are a complement to medication and invasive treatment.

There are solid scientific evidences which indicate the significant contribution of rehabilitation services, demonstrating a positive Cost - Benefit-(Cost-Effectiveness). (Balady, Williams et al , 2007., Drori, 1997).

Cardiac patient's rehabilitation requires a series of complex actions, in order to bring assist the cardiovascular patient to achieve an optimal physical, mental, and psychological performance level, so as to allow him to recapture his place in society, as an independent individual (World Health Organization, 1964). The current definition for Cardiac rehabilitation (CR) has also adopted a comprehensive approach (Public Health Services of the United States, 1995, Israel Heart Society, 2005).

C R P for CHD patients were established in the 1950's, when it became was found that the physiological effort reactions among coronary heart patients, is not significantly different than the reactions of healthy people, The difference is due to prolonged bed rest (Chapman & Fraser,1954).

Rehabilitation programs were initially conducted in the hospital, designated for patients recovering a MI.

Apparently, early Mobilization of these patients improved their health to a greater extent than a prolonged bed rest, which was common at that day and age.

Since the 1960's dramatic progress has occurred, pertaining to both diagnostic and treatment methods of CHD and also the scientific knowledge concerning about risk factors, the formation of the disease and its progress. The approach toward the rehabilitation of CHD patients has drastically changed but they are based only on endurance training and the main contribution is for the cardiovascular system.

Contemporary conventional rehabilitation programs are not always held at hospitals. They consist of a much broader range of clinical situations, referring to a variety of topics, and apply modern technology for monitoring, computerization and special emphasis on instructed physical training, according to which physical training begins

earlier and less gradually than before.

(Porat,1999., Scheinowitz, 2000).

The main goal of rehabilitation programs is to allow heart patients to restore an active, productive, quality, and optimal lifestyle, within the limitations dictated by the disease process.

Other goals are:

- Prevention progression and encouraging regressed the atherosclerotic process in patients suffering a coronary heart disease (CHD).
- Reducing risk for cardiac events such as sudden death, recurrent infarction, unstable angina syndrome, and reducing the need for invasive interventions.
- Be part of the overall system of prevention CVD, (Scheinowitz , (2000).

Today there are distinct recommended components for an effective cardiac rehabilitation/secondary prevention program, using the clinical guidelines of all Scientific medical institutions in the world (for each component and phase of the rehabilitation/secondary prevention program) with emphasis on the exercise training component.(Balady, Williams et al , 2007).

The effect of Physical Exercise Training in CRP

Studies have demonstrated a reduced rate of initial CHD events in physically active people, (Shephard & Balady, 1999, Thompson, Buchner, Piña, Balady et al, 2003). These findings, along with those from studies that demonstrate biologically plausible cardioprotective mechanisms provide strong evidence that physical exercise training at least moderate intensity reduces the risk of coronary events, thus leading to the conclusion that physical inactivity is a major CHD risk factor.

An even greater impact is seen when the endurance exercise program is of sufficient intensity and volume to improve aerobic capacity. Data from the Health Professionals' Follow-up Study (Tanasescu , Leitzmann , Rimm ,et al ,2002), also provide evidence that as little as 30 minutes per week of strength training may reduce the risk of an initial coronary event.

In the absence of definitive randomized controlled trials, meta-analyses of smaller studies have been used to assess the role of exercise training, alone or as part of a comprehensive CRP on morbidity and mortality rates of CHD patients. Meta-analyses based on studies performed in the 1970s and 1980s and reviewed in the 1994 AHA

scientific statement on CRP (*Circulation*, 1994) and the Agency for Health Care Policy and research guidelines (Wenger, Froelicher, Smith, Philip et al, 1995), revealed a statistically significant reduction in both cardiac and total mortality after completion of CRP that included exercise training (O'Connor et al, 2002), and demonstrated the independent effects of the exercise component of contemporary CRP on morbidity, mortality, and other outcome variables.

These medical advances include attenuation of residual myocardial damage from acute coronary occlusion by emergent medical interventions and pharmacological therapy to reduce myocardial oxygen demands; development and use of antiplatelet and anticoagulant drugs; prompt coronary revascularization by thrombolysis or percutaneous interventions; and more frequent use of revascularization procedures. Wider prophylactic use of adjunctive cardioprotective drugs (e.g, statins), as demonstrated in definitive clinical trials, has been shown to be effective for reducing cardiovascular morbidity and mortality rates. Furthermore, biotechnical advances that have improved the survival rates of cardiac patients include conventional or drug-eluting coronary stents, implantable cardioverter defibrillators, and biventricular pacing and left ventricular assist devices for treating patients with chronic heart failure.

In light of these advances, the additional effect of exercise training on morbidity and mortality rates in current cardiac rehabilitation participants is unclear.

Taylor et al (2004) reported encouraging findings in a meta-analysis based on a review of 48 randomized trials of 6 months' duration that compared outcomes of exercise-based rehabilitation with usual medical care. This meta-analysis, which updated and made Amendments important methodological corrections, Studies pointed that exercise-based cardiac rehabilitation was associated with lower total and cardiac mortality rates compared with usual medical care (Taylor et al, 2004) , which was in agreement with previous reports. Subgroup analysis showed that mortality rates did not differ between programs limited to exercise and those providing more comprehensive secondary interventions, or between pre- and post-1995 studies. Favorable trends also were noted for a lower incidence of nonfatal myocardial infarction and revascularization procedures in cardiac patients who received exercise-based rehabilitation, but these trends did not achieve statistical significance.

Data from a limited number of studies included in this meta-analysis and also showed more favorable changes in some modifiable cardiovascular risk factors among patients who received exercise therapy. Few data were provided in these studies on the use of acute thrombolytic therapy and adjunctive cardioprotective drugs. Furthermore, quality of life was assessed, via a variety of measures, in only 25% of the clinical trials, and similar improvement was noted in both the exercise-based rehabilitation and control groups.

Psychosocial Variables in cardiac rehabilitation Intervention programs

Psychosocial dysfunction is common in patients receiving cardiac rehabilitation treatment. These problems include depression, anger, anxiety disorders, social isolation, psychological social and physical subjective well-being and other various Psychosocial Variables (Leon et al,2005) .

Observational studies have demonstrated associations between psychosocial disorders and the risk of initial or recurrent cardiovascular events, (Lett et al, 2004). The randomized multicenter trial, Enhanced Recovery in CHD Patients (ENRICH), assessed whether morbidity (recurrent MI) or mortality would be reduced by psychosocial interventions in 2481 people hospitalized for acute myocardial infarction associated with depression and low social support (Berkman et al,2003). Treatment for depression was provided through cognitive behavior therapy and selective serotonin reuptake inhibitors, when indicated. The ENRICH intervention did not improve event-free survival; however, both depression and social isolation improved in the intervention and control groups. Nevertheless, even if psychosocial interventions ultimately are shown not to alter the prognosis of CHD patients, they remain - until today - an integral part of cardiac rehabilitation services to improve the psychological well-being and quality of life of cardiac patients, but the field of treatment in the psychosocial risk factors by physical strength training treatment (and not only by cognitive behavior or drug therapy / treatment) especially in elderly CR patients is very lackin.

Real need arose for systematic examination and for establishing research assumptions, concerning the improvement of the physical and psychosocial variables among the cardiac patients, through a program based on strength training. This research present research pioneer about as already described in the introduction.

Being tested for the first time the need for a program based on isometric strength training for improvement of the physical and psychosocial variables among the cardiac patients.

The Purposes

1. To investigate the effect of participation in strength-based cardiac rehabilitation program on physical fitness for men and women patients with CHD by compared the patients' baseline data at the start of the program with the data at the end of the program.
2. To investigate the effect of participation in strength-based cardiac rehabilitation program on psychosocial variables for men and women patients with CHD by compared the patients' baseline data at the start of the program with the data at the end of the program.

Hypotheses

This study examines the significance of a unique rehabilitation program and determines the effect of participation in CRP on physical and psychosocial variables in personalized rehabilitation programs for patients with CHD.

The following hypotheses were formulated:

1. Average muscle strength measurements at the end of the program would be significantly higher than the average at the start of the program.
2. Average levels of subjective well-being at the end of the program would be significantly higher than the scores at the start of the program.
3. Average levels of life satisfaction at the end of the program would be significantly higher than the scores at the start of the program.
4. Average levels of state anxiety at the end of the program would be significantly lower than scores at the start of the program.
5. Average depression levels at the end of the program would be significantly lower than scores at the start of the program.
6. The subjects' physical improvement will be explained by the number of instances of treatments and the demographic variables (age and gender).
7. The improvement in the SWB index will be explained by an improvement in the physical measures (right hand and left hand) and the demographic variables.
8. The improvement in the LS will be explained by an improvement in the physical measures (right hand and left hand) and the demographic variables.
9. The improvement in the state anxiety measure will be explained by an improvement in the physical measures (right hand and left hand) and the demographic variables.
10. The improvement in the depression measure will be explained by an improvement in the physical measures (right hand and left hand) and the demographic variables.

2. Methods

Study type: We conducted a longitudinal study with repeated measures at baseline and after the intervention.

Quantitative Prospective analytical study
(prospective –follow up).

The study population included 200 patients (162 were men -81%- and 38 were women -19% -), who joined the cardiac rehabilitation program and were referred by the cardiology department of a main public hospital in northern Israel. In cohorts of three months, all the patients suffered from CHD and were admitted to the hospital after MI. In addition to the medical tests, the patients underwent physical fitness tests and physical effort / stress tests both at the beginning and end of the study. They also filled out questionnaires regarding psycho-social variables both at the beginning and end of the study.

The average age of the participants was 59.7 years old, with a standard deviation of 10.1 years.

2.1 Variables and tools

The measures used in this study are based on accepted research methods.

Each one of the 4 tools/questionnaires for measure the psycho-social variables was developed on the theoretical basis of the variable studied; the questionnaires were anchored in a wide theoretical framework and stand up to structural inspection of reliability and validity. They have been used in tens of thousands of studies and tested on various kinds of subjects: children, adults, and seniors, both female and male. These tools have proven very convenient for research, and meet the needs in the field as they can be conducted relatively quickly and evaluated easily, as well as translated into many languages including Hebrew.

1. Hand gripper Strength as Measured by the Handgrip Strength Test Dynamometer – (HGSD - HGST). Measure the maximum isometric strength of the hand and forearm muscles (Willcox et al, 2006).
2. Subjective well-being as measured by the Affect Balance Scale (ABS) (Bradburn , 1969). To assess positive and negative affect as indicators of life satisfaction and/or well-being.

3. life satisfaction as measured by the Self-Anchoring Striving Scale (SAS) (Cantril, 1965). To measure the individual's perception of his or her satisfaction with life.
4. State Anxiety as measured by the State-Trait Anxiety Inventory (STAI-S), (Spielberger, C. D., Gorsuch, R. L., Lushene, R. E., 1970; 1983). Used to measure anxiety in adults.
5. Depression as measured by the Beck Depression Inventory (BDI).

(Beck A.T., Ward C. H., Mendelson M., Mock J., Erbaugh J 1961). To assess the existence and severity of symptoms of depression.

2.2 Procedure

Rehabilitating intervention began shortly as possible after hospital release (within three weeks from discharge) in cohorts of three months and a total sum of 24 sessions per cohort.

At the beginning of the first day of the program the patients took their first HGST/HGDT dynamometer test to evaluate their grip strength (arm muscles'/hand muscles'), after which they filled the battery of questionnaires: ABS, SAS, STAI-S and BDI to evaluate the psychosocial variables' levels. Later that day they performed a physical training exercise that was comprised of two parts / types:

1. Aerobic exercise which activates large groups of muscles (frequency twice a week, for a duration of 20 to 30 minutes, and intensity of 50 to 65 percent of the maximal heart-rate received in the sub-maximal stress-testing (effort test) before entering the program. The patients were heart-monitored continuously during the aerobic exercise on a digital screen.

2. Isometric and dynamic strength/resistance exercises for the skeletal muscles system, using weights and bands at a moderate intensity of 40 to 50 percent of the maximal isometric strength effort test-HGSD (measuring by KG units in entering to the program) for 30 to 40 minutes.

This part of the isometric strength based physical training was first tried out here and is unique to this rehabilitation program - it does not exist in current CRP.

All exercises/treatments were closely supervised by the program's physician and physical training experts.

This training program was personally adapted to suite each patient individually, in accordance with the patient's evaluation: determining the patient's risk level and preserving the "efforts bar" principal (personalized rehabilitation program-PRP). This aspect of the physical training was also first put to use here and is unique to this program, it also does not exist in other cardiac rehabilitation programs.

It is important to emphasize that the clinical guidelines on this matter states: "It is not advisable at this stage to perform muscle resistance exercises (weightlifting or isometric exercises)" (Scheinowitz,2000). As opposed to clinical guidelines , which still appears in all the international cardiologic organizations' rehabilitation programs,

and which is partially based on the medical institution's conservative approach regarding the risk involved in this type of physical exercise (dynamic resistance training / weightlifting or isometric exercise), there is literature that presents up-to-date evidence of this type of exercise's unique contribution. Based on this evidences we took an innovative approach and included in the program exercises based on strength training as mentioned earlier, of course while monitoring and close supervision by the staff.

At the end of the last day of the program the HGST/HGDT dynamometer test was taken for the second time to examine the grip strength after which the patients filled the battery of questionnaires: ABS, SAS, STAI-S, BDI, to evaluate the psychosocial variables' levels.

2.3 STATISTICAL ANALYSES

Standard parametric statistical techniques were used throughout. The mean and standard error of the mean (SEM) were calculated and used to describe and summarized the data. The standard deviation (SD) was used when appropriate to illustrate the dispersal of scores around the mean.

The t-test Independent Samples was employed when testing the significance of the difference between two means using the appropriate test for matched or independent means.

T-test Paired Samples: to examine if the difference found between the means of two dependent samples is statistically significant.

Analysis of variance was also used where applicable. Differences and relations were considered significant at the 5% level.

Relations between two or more variables were evaluated using the Pearson Correlation Test. Correlation and regression methods were used to identify interrelations between variables and to measure average improvements over time.

Multiple Linear Regressions: to predict the dependent variable based on a number of independent variables.

3. Findings

The results of the t-tests indicate that there is a significant difference ($P < .001$) between the physical and psychosocial measures of the subjects before and after the experiment, this is in accordance with the hypotheses H1–H5 which confirmed the following:

H1 – A significant improvement in left hand and right hand gripping strength.

H2 – An increase in the number of positive statements and a decrease in the number of negative statements indicating a significant improvement in the SWB measure.

H3 – Increased life satisfaction.

H4 – A decrease in state anxiety.

H5 – A decrease in the level of depression.

We note that the resulting improvement was significant for both men and women.

The results indicate that in accordance with the hypotheses H2–H5, there was a very significant improvement (at a level of $P < .001$) in all psychosocial measures of both the male and female patients.

The last phase of the test referred to hypotheses 6 – 10, which propose that the improvement in physical and psychosocial measures found in the study are due to the physical rehabilitation that the participants underwent.

There are significant correlations at the 0.01 level both between the number of instances of treatments and the physical improvement (strength in both hands), and between the improvement in psychosocial measures and the improvement in the physical condition. No relationship was found between the number of instances of treatments and an improvement in psychosocial measures. The obtained results were similar in the sample of men and the sample of women.

In order to strengthen the study's hypotheses, we examined whether additional variables beyond an improvement in physical fitness can account for the improvement in the psychosocial measures over the course of the program. Linear regressions were performed using the enter method (linear regression-enter) where the dependent variables are improvements in physical and psychological measures, and the independent variables are the number of instances of treatment, improvement in physical fitness (in regressions in psychological measures) and the results of the regression indicate that the number of treatments is the primary explanation for the increase in physical fitness. The independent variables – number of treatments, age and gender – were significant predictors in the improvement of physical measures (right hand strength, left hand strength, strength in both hands). Significant predictors (variables) explained 19.3%, 20.7% and 26.7% respectively of total explained variance. Thus, hypothesis 6 is confirmed.

The findings indicate that the physical measure – strength in both hands, age and gender – were significant predictors of improvement in psychological measures (wellbeing, life satisfaction, state anxiety and level of depression). The significant predictions explained 29%, 23.9%, 8.7% and 11.6% respectively of all the explained variance, and as such contributed to obtaining confirmation of hypotheses H7-H10. The variable of physical improvement in both hands is the most influential variable in explaining the improvement in psychological measures. The variable of gender has an influence only upon improvement in state anxiety while the variable of age does not have a great influence on the improvement in satisfaction, wellbeing or level of depression.

The regression of multiple variables (strength in hands, age and gender) did not change the level of explanation of R^2 : i.e. the primary explanation for the improvement in psychosocial measures is due to improvement in physical strength. This was also the case with regression with multiple variables.

4. Conclusions

Significant differences were found in each one of the study's variable from the beginning of the program to the end for both men and women. The improvement in the element of strength contributed significantly to the improvement in physical fitness and to the improvement in all the psycho-social variables.

The findings gave confirmation to all of the study's hypotheses. The procedures taken and the findings shed light on the important role of improvement of physical strength on psycho-social variables amongst patients undergoing rehabilitation. These variables constitute independent risk factors for CHD.

Since there is a distinct lack of scientific theoretical background on this issue in the professional literature, the findings of this our research may shed more light on understanding the major mechanisms whereby strength activity influences psycho-social factors amongst heart patients undergoing rehabilitations, thereby helping clinicians and patients take better care of their hearts and lives.

5. THE CONTRIBUTION

We decided to examine the contribution of a unique physical activity program based on strength and resistant training, and which would include isometric and dynamic strength training for the improvement in (separately) cardiac patient's physical and psychological health state in CRP. The contribution of the present study lies in its clarification of the relationship between strength and resistant training and the improvement in cardiac patient's physical and psychosocial variables. The study examines the hypothesis that through the improvement in the isometric and dynamic strength, the CHD patients will present improvement in their physical and psychosocial variables/characteristics. The present study wished to demonstrate that these CHD patients should be treated with an element of strength exercises which will contribute for the improvement of the rehabilitation process and even to primary and secondary prevention in decreases the risk of CHD.

The central working assumption of this study is that this physical activity in the framework of heart patient rehabilitation influences and significantly improves measures of physical fitness and therefore decreases the risk of CHD, and is thus of critical importance to patients.

The clear evidence that physical fitness and strength exercise as part of this CRP significantly affect physical fitness measures - we demonstrates the relationship between the number of instances of treatments and an improvement in hand strength, and also demonstrates the relationship between physical improvement and improvement in psychosocial condition - and lead to increases in subjective well-being and life satisfaction levels, a decrease in levels of state anxiety and depression and a faster return to functional activity have implications for future planning of health measures and intervention on a national (and international) level in health policy by the Health Ministry and by all HMOs in Israel, as well as in other developed nations. To be more precise, the large gaps which were observed between physical fitness/ability at the end of the program and the low level of physical ability at the beginning of the program, and the correlations, some relatively high, which were found between the improvement in physical ability and the improvement in psychosocial variables, confirm our these contribution, and clarify that physical ability constitutes a central component in heart patient rehabilitation, affect prognosis, and also the success in the

specific rehabilitation measures and general health measures. Our findings add a significant element to this field.

The study's findings therefore contribute a very important dimension that not included in previous reports: The effect of isometric resistance training on patients recovering from a cardiac event. Despite the fact that in recent years a number of researchers began recommending tracking and investigating this topic (Pollock et al, 2000), there is still a lack of reporting on studies of this type of physical exercise intervention. Therefore, the CRP which include strength training and isometric strength training have a clear potential to contribute to the improvement of psychosocial and physical variables, and as such to contribute to achieving the goals of cardiac rehabilitation program patients thus lowering patients' risk levels for repeat cardiac events. This study is the first to have granted an empirically validated explanation proposing the importance of physical activity/ strength training, including isometric strength, among rehabilitation patients.

There is a distinct lack of scientific theoretical background on this issue in the literature, this study's findings may shed more light on the major mechanisms whereby strength activity influences psychosocial factors amongst cardiac patients undergoing rehabilitation, thereby helping clinicians and patients take better care of their hearts and lives.

6. INNOVATION

Contemporary CRP for CHD patients are based only on endurance training, and avoid including one of the most important component in the rehabilitation process: the strength training, thus losing the unique contribution and the benefits of strength training for cardiac patients that consisting mainly older adults. This population is associated with a number of physiologic, psychosocial and functional declines that can contribute to increased disability, frailty, and falls as well as increased exposure to risk factors for chronic diseases such as CHD and so forth. Rehabilitation patients suffer from a physical disadvantage and are characterized by poor physical condition and a difficult mental state. This is entry into a State of closed circle of illness condition.

Contributing factors are the loss of muscle mass and strength as age increases, a phenomenon called sarcopenia. Sarcopenia can result or be exacerbated by certain chronic conditions, and can also increase the burden of chronic disease. Our research has demonstrated that strength-training exercises have the ability to combat weakness and frailty and their debilitating consequences. Done regularly (e.g., 2 days per week), these exercises build muscle strength and muscle mass in older adults CHD population (!) and get out the State of closed circle of illness condition, (and preserve bone density, reduce the risk of osteoporosis and the signs and symptoms of numerous chronic diseases such as CHD, arthritis, and type 2 diabetes, independence, and vitality with the disease and the age as many other studies have shown). In addition, strength training also has the ability to reduce or improve the psychosocial risk factors: depression, state anxiety, life satisfaction and well-being as we demonstrated in this research.

The scientific literature lacks systematical information regarding the effect of physical exercise based on strength training in general, and isometric strength in particular, on cardiac patients following a cardiac event, and in predicting the success of such training as part of a long-term intervention. On the theoretical research level this research innovation can contribute a great contribution to close this gap in knowledge.

On a practical level this research innovation can contribute a crucial contribution in achieving the goals of the cardiac rehabilitation intervention programs through the optimization of the programs.

Achieving these goals may have far-reaching implications for the future of public health policies, including health indicator planning and intervention on the national and even international levels and lead scientists and experts to examining these approaches to improving physical and psycho-social variables by intervention strength training , and even updating existing clinical recommendations (clinical guidelines) for cardiac rehabilitation programs.

The main innovations of this research:

1. Isometric and dynamic strength/resistance exercises for the skeletal muscles system, using weights and bands. This part of the physical training was first tried out here and is unique to this rehabilitation program - it does not exist in current cardiac rehabilitation programs.
2. Each part of the training program was personally adapted to suite each patient individually (in accordance with the patient's evaluation: determining the patient's risk level and preserving the "efforts bar" principal). This aspect of the physical training was also first put to use here and is unique to this program, it also does not exist in other cardiac rehabilitation programs (these components were chosen to specifically fit - tailor-made - the patient's medical and functional condition, (personalized rehabilitation program -PRP).
3. Treatment in the psychosocial variables / risk factors by physical strength training treatment (and not only by cognitive behavior or drug therapy / treatment) especially in elderly CR patients.
4. Examine separately the suitability of the strength training program to be used as a predictor of the success of improvement in psychosocial and physical state in Personalized Rehabilitation Programs for CHD Patients.
5. The combination of all these innovations in this one study.

Real need arose for systematic examination and for establishing research assumptions, concerning the improvement of the physical and psychosocial variables among the cardiac patients, through a program based on strength training. This research present research pioneer about as already described in the introduction.

Being tested for the first time the need for a program based on isometric strength training for improvement of the physical and psychosocial variables among the cardiac patients.

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