ISSN: 2378-2951

Panigrahi and Amabile. Int J Clin Cardiol 2024, 11:295
DOI: 10.23937/2378-2951/1410295
Volume 11 | Issue 4
Open Access

International Journal of Clinical Cardiology

CLINICAL RESEARCH

Improving Left Ventricular Ejection Fraction with AHA'S Life's Simple 7: A 25-Year Clinical Experience

Gunadhar Panigrahi, MD, FACC, DipABLM, FACLM[1,2] and Thomas Amabile, MPH[3]*

[1]*Cardiovascular Wellness Clinic, Sentara Cardiology Specialists, USA*

[2]*Clinical Assistant Professor in Medicine, Eastern Virginia Medical School, USA*

[3]*Eastern Virginia Medical School, USA*

***Corresponding author:** *Gunadhar Panigrahi, MD, FACC, DipABLM, FACLM, Cardiovascular Wellness Clinic, Sentara Cardiology Specialists; Clinical Assistant Professor in Medicine, Eastern Virginia Medical School, 2075 Glenn Mitchell Drive, Suite 400, Virginia Beach, VA 23456, USA, Tel: 757-507-8900, Fax: 757-301-7182*

Abstract

Background: Heart failure is a terminal illness and has multiple contributing factors including suboptimal practice of best lifestyle choices.

Objective: This study was undertaken to incorporate lifestyle practices as described by the American Heart Association's Life's Simple 7 (and recently updated to - Life's Essential 8) to improve left ventricular systolic function, in addition to the standard Guideline-Directed Medical Treatment (GDMT).

Methods: Patients with reduced left ventricular systolic function characterized by ejection fraction (EF) less than 50% are incorporated in this study group. They have been treated medically as per GDMT plus incorporating appropriate lifestyle changes - diet (whole food plant-based diet: WFPBD), exercise, weight control, cessation of tobacco and other substance abuse, as well as counseled on stress management and sleep hygiene.

Results: A total of 132 patients were treated in the cardiology wellness clinic over the past 25 years (1998-2023). Out of them, 101 patients (76.5% of the total cohort) have achieved improved left ventricular systolic function from an average baseline EF of 30.4% to an EF of 51.9% ($p < 0.0000$) at the conclusion of this study. Along with this, they have achieved lower HR: -7.47 ($p < 0.0000$), diastolic BP: -5.58 mm of Hg (p 0.0001), weight in Kg: -1.86 (p 0.0283), BMI (kg/m2): -0.67 (p 0.0130), total cholesterol: -19.14 mg/dl (p 0.0002), LDL cholesterol: -18.03 mg/dl (p 0.0001), LVIDd (left ventricular internal diameter in end-diastole): -0.40 cm ($p < 0.0000$), and LVIDs (left ventricular internal diameter in end-systole): -0.77 cm ($p < 0.0000$).

Conclusion: Incorporating AHA'S Life's Simple 7 choices to the standard medical management has shown significant improvement in left ventricular dimension (reverse remodeling) and left ventricular ejection fraction (LVEF); and improvement in the common risk factors those adversely impact in the recovery of left ventricular systolic function.

Keywords

AHA's life's simple 7 (and Life's Essential 8), Whole food plant-based Diet (WFBPD), Left ventricular internal diameters (LVID), Left ventricular ejection fraction (LVEF)

Introduction

There have been concerning trends in the incidence and prevalence of heart failure (HF) hospitalizations and mortality over the past few decades. According to the NHANES 2017-2020, approximately 6.7 million Americans over 20 years of age have HF. This is expected to rise to 8.5 million by 2030. The prevalence of HF among US adults is approximately 1.9% to 2.6% for the overall population and is higher among older patients, which is expected to increase to 8.5% among 65 to 70-year-olds [1]. With 6.7 million HF patients in US in 2020, an all-cause annual mortality rate has been estimated to be 9%. In a study from GWTG (Get With The Guidelines) registry of 39,982 patients hospitalized with HF with linked Medicare data and following through 2014 in risk-adjusted survival analysis, patients with HFrEF, HF with mildly reduced EF (HFmrEF, left ventricular EF 41%-49%) and HFpEF had similar 5-year mortality: 75.3%, 75.7%, and 75.7%, respectively [hazard ratio 0.99, 95%

Citation: Panigrahi G, Amabile T (2024) Improving Left Ventricular Ejection Fraction with AHA'S Life's Simple 7: A 25-Year Clinical Experience. Int J Clin Cardiol 11:295. doi.org/10.23937/2378-2951/1410295

Accepted: August 24, 2024: **Published:** August 26, 2024

CI 0.97-1.046] [2,3]. As the risk factors for HF, such as obesity, diabetes, hypertension, hypercholesterolemia, and exposure to cardiotoxicity increase; the burden of HF will likely to increase. Despite expansion of guideline directed medical therapy (GDMT), the mortality rate and rehospitalization rate for HF remain high. An estimated 90% of the $4.3 trillion annual cost of health care in the United States is spent on medical care for chronic disease management. For many of these diseases, diet is a major risk factor, so modest improvements in diet could have a significant impact on cost saving [4].

Incorporating American Heart Association's "Life's Simple 7" (and recently Life's Essential 8) lifestyle choices [5,6], and healthy dietary interventions [7,8], in addition to pharmacologic management in HF, has the potential for improving these grim outcomes.

Patient Selection and Method

In this prospective observational study from 1998 through 2023 in a cohort of 132 patients with low left ventricular ejection fraction (LVEF < 50%) have been treated and followed longitudinally by a single provider (GP) in the Cardiovascular Wellness Clinic. They were divided in to two groups: Group A, who have improved their LVEF by 10% or greater compared to the LVEF at baseline (responders, n = 101) and the Group B patients who have not achieved improvement and/or have decline in LVEF compared to the baseline LVEF (non-responders, n = 31), despite similar treatments. The Group B patients have end stage cardiomyopathy, advanced renal disease, medical noncompliance, and been treated for various cancers; and this may explain their non-response to treatment. The outcome of patients in Group A (responders) is the major focus of this study.

All the patients in this study have received GDMT - Beta-blockers, ACE inhibitors, ARB agents, ARNI agents, Aldosterone blockers, SGLT2 inhibitors, hydralazine/isordil, and diuretics as indicated. In addition to these medical treatments, they have been counseled on making appropriate lifestyle changes based on the AHA's Life's Simple 7 parameters (and since 2022, Life's Essential 8 principles are adopted [9]). These include: 1) Heart healthy diet - mostly whole food plant-based diet (vegetables, fruits, beans, whole grains, seeds and nuts), and minimally processed foods. They were advised to avoid - meat, eggs, cheese, oil, added fat, added sugar, and high-fat milk. They are particularly recommended to avoid ultra processed foods and drinks (UPFD) [10], 2) Weight control with the goal of achieving BMI less than 25 kg/m^2, 3) Engage in regular exercise of moderate-vigorous intensity/vigorous intensity of 150/75 minutes per week. In addition, they were encouraged to add resistance training at least 2 days a week, 4) They were counseled to avoid risky substances - tobacco, alcohol, and marijuana products, 5) They were counseled to maintain ideal blood pressure control of 120/80 mm of Hg, 6) The goals were to achieve good control of lipids - total cholesterol of less than 150 mg/dl, triglyceride level less than 150 mg/dl, HDL cholesterol level higher than 40 mg/dl in men and 50 mg/dl in women, 7) Control of fasting blood glucose level of less than 100 mg/dl, and HbA1c less than 6.0%. Most recently added lifestyle changes to include 8) Restorative sleep of 7-8 hours, and 9) Dealing with stress/anxiety with mediation and relaxation techniques (my addition). These goals were discussed with each office visit to gauge their progress in adopting optimal lifestyle changes, and additional counseling were provided when needed. They were encouraged to monitor their weight, blood pressure, physical activities, and to comply with the prescribed diet. They were asked to bring along the entries of their weight and blood pressure records to the next clinic visit for discussion. Their progress was closely monitored with clinic visits at 3 months, 6 months, and at 12 months based upon their clinical need and progress. Blood chemistries which included - basal metabolic profile, liver function studies, lipid profile, and when indicated HbA1c, and were done prior to the clinic visits.

In addition, echocardiographic studies were done periodically based on the clinical progress, symptoms, and to gauge response to treatment with measurements of left ventricular end-diastolic and end-systolic dimensions, and measurement of EF calculated based on the Simpson's bi-plane method.

Emphasis had been made on educating the patients in the cardiovascular disease process with reference to heart failure using animation. They were educated on diet (WFPB) by means of pamphlets, meal plans, label reading - to avoid saturated fat, high cholesterol, excess salt, and added sugar. Cooking methods of broiling, steaming, and roasting to preserve nutritional value were encouraged, and to use minimal or no oil in food preparation (instead using water or vegetable broth). The composition of meal planning incorporated to the breakdown of calories to nearly 75% complex carbohydrates, 15% plant protein, and 10% fat. Additionally, they were educated on high fiber containing foods to maximize intake of 40 grams of fiber daily for men and 30 grams for women [11-14].

Statistical Analysis

The statistical data analysis has been done by using Microsoft Excel statistical analysis package. Data are reported as mean and 1 SD. Intra-group analysis are done using the Student's t-test, and p-value < 0.05 is considered significant.

Result

Group A cohort

This analysis includes 101 patients managed in the cardiovascular wellness clinic from 1998 through 2023, and were identified as showing positive improvements

Table 1: Comparing the mean baseline and final measurements in Group A.

Group A (n = 101)				
	Baseline	Final		
Clinicals	**Mean (SD)**	**Mean (SD)**	**Δ**	**p-value**
HR, bpm	79.56 ± 14.98	72.09 ± 12.29	-7.47	< 0.0000
Systolic BP, mmHg	131.09 ± 20.35	127.62 ± 16.34	-3.47	0.0960
Diastolic BP, mmHg	78.17 ± 11.86	72.59 ± 10.43	-5.58	0.0001
Weight, kg	92.26 ± 22.35	90.40 ± 22.78	-1.86	0.0283
BMI, kg/m^2	30.84 ± 6.28	30.17 ± 6.62	-0.67	0.0130
T. Chol, mg/dl	166.27 ± 48.96	147.13 ± 35.75	-19.14	0.0002
Trig, mg/dl	126.31 ± 87.10	112.57 ± 50.88	-13.74	0.0601
HDL, mg/dl	47.59 ± 13.40	47.03 ± 11.09	-0.56	0.5562
LDL, mg/dl	95.00 ± 44.85	76.97 ± 31.29	-18.03	0.0001
FBS, mg/dl	120.25 ± 42.30	118.75 ± 41.65	-1.5	0.7674
HbA1c, %	7.22 ± 1.75	6.85 ± 1.18	-0.37	0.1631
LVIDd, cm	5.35 ± 0.74	4.95 ± 0.62	-0.4	< 0.0000
LVIDS, cm	4.37 ± 0.93	3.6 ± 0.65	-0.77	< 0.0000
EF, %	30.44 ± 9.05	51.85 ± 7.56	+21.41	< 0.0000

in left ventricular function following lifestyle treatment. Mean age of patients in the study was 67.6 years, ranging from age 39 to 95. The cohort consisted of 62 men and 39 women. The average time between baseline and final measurements was 12.5 years. Individuals in this cohort had diagnoses of non-ischemic cardiomyopathy (n = 55), ischemic cardiomyopathy (n = 33), and mixed cardiomyopathy (n = 13).

When comparing the mean baseline and final measurements in group A, significant decreases were found in heart rate: -7.47 bpm (p = < 0.0000), diastolic blood pressure: -5.58 mmHg (p = 0.0001), weight: -1.86 kg (p = 0.0283), BMI: -0.67 (p = 0.0130), total cholesterol: -19.14 mg/dL (p = 0.0002), LDL: -18.03 mg/dL (p = 0.0001), LVIDd (left ventricular diameter in diastole): -0.40 cm (p = < 0.0000), and LVIDs (left ventricular diameter in systole): -0.77 cm (p = < 0.0000). A significant increase was found in LVEF: 21.41% (p = < 0.0000) (Table 1).

When comparing the mean baseline and final measurements of those previously diagnosed with non-ischemic cardiomyopathy (NICM), significant decreases were found in heart rate: -7.81 bpm (p = 0.0023), diastolic blood pressure: -5.66 mmHg (p = 0.0013), total cholesterol: -19.91 mg/dL (p = 0.0109), LDL: -19.51 mg/dL (p = 0.0055), LVIDd: -0.44 cm (p = < 0.0000), and LVIDs: -0.86 cm (p = < 0.0000). A significant increase was found in LVEF: 22.65% (p = < 0.0000) (Table 2).

When comparing the mean baseline and final measurements of those previously diagnosed with ischemic cardiomyopathy (ICM), significant decreases were found in heart rate: -5.51 bpm (p = 0.0098), diastolic blood pressure: -29.99 mmHg (p = 0.0172), weight: -3.13 kg (p = 0.0337), BMI: -1.02 (p = 0.0443), total cholesterol: -18.09 mg/dL (p = 0.0130), LDL: -15.84 mg/dL (p = 0.0163), LVIDd: -0.35 cm (p = < 0.0012), and LVIDs: -0.64 cm (p = < 0.0000). A significant increase was found in LVEF: 19.73% [p = < 0.0000] (Table 2).

When comparing the mean baseline and final measurements of those previously diagnosed with mixed cardiomyopathy, significant decreases were found in heart rate: -11.00 bpm (p = 0.0270), weight: -4.58 kg (p = 0.0364), BMI: -1.43 (p = 0.0291), and LVIDs: -0.67 cm (p = < 0.0000). A significant increase was found in LVEF: 20.46% [p = < 0.0000] (Table 2).

The increase in LVEF from the baseline to the final evaluation after treatment (Figure 1) is inversely correlated with decrease in BMI, decrease in diastolic blood pressure, reduced total cholesterol, and reduced LDL cholesterol (Figure 2).

A case of NICM is illustrated with the left ventricular echocardiographic findings before treatment (baseline) and after treatment (final), along with the coronary angiography at baseline in Figure 3.1. Similarly, a case of ICM is illustrated in Figure 3.2.

Group B cohort

This cohort consists of 31 patients with the mean age of 69.3 years, ranging from 47 years to 94 years, and 19 were men and were 12 women. Their characteristics are included in Table 3.

In Table 4, the incidence of different categories of cardiomyopathy, utilization of pharmacological agents and CRT (Cardiac Resynchronization Therapy) between the two groups are summarized (Table 4). These treatments were similar between the two groups.

Discussion

The pathophysiology of heart failure (HF) with reduced

DOI: 10.23937/2378-2951/1410295

Table 2: Comparing the mean baseline and final measurements of those previously diagnosed with non-ischemic cardiomyopathy (NICM), ischemic cardiomyopathy (ICM) mixed cardiomyopathy.

	Group NICM (n = 55)				Group ICM (n = 33)				Group Mixed (n = 13)			
	Baseline	Final			Baseline	Final			Baseline	Final		
Clinicals	**Mean (SD)**	**Mean (SD)**	**Δ**	**p-value**	**Mean (SD)**	**Mean (SD)**	**Δ**	**p-value**	**Mean (SD)**	**Final (SD)**	**Δ**	**p-value**
HR, bpm	82.75 ± 16.01	74.94 ± 11.79	-7.81	0.0023	73.18 ± 10.66	67.67 ± 11.81	-7.81	0.0098	82.69 ± 15.99	71.69 ± 12.89	-11.00	0.0270
Systolic BP, mmHg	129.70 ± 18.89	127.37 ± 18.36	-2.33	0.3875	130.58 ± 20.94	126.30 ± 15.03	-2.33	0.2574	138.15 ± 24.73	132.00 ± 9.20	-6.15	0.3767
Diast BP, mmHg	80.20 ± 11.71	74.54 ± 10.16	-5.66	0.0013	145.44 ± 12.06	115.45 ± 10.74	-5.66	0.0172	75.23 ± 11.20	74.92 ± 8.06	-0.31	0.9178
Weight, kg	94.00 ± 23.40	93.52 ± 25.04	-0.48	0.6894	89.11 ± 20.09	85.98 ± 18.12	-0.48	0.0337	92.65 ± 23.94	88.07 ± 22.52	-4.58	0.0364
BMI kg/m^2	31.76 ± 6.52	31.50 ± 7.35	-0.26	0.4595	29.45 ± 5.02	28.43 ± 4.63	-0.26	0.0443	30.52 ± 7.80	29.09 ± 6.96	-1.43	0.0291
T. Chol mg/dl	179.10 ± 49.02	159.19 ± 35.05	-19.91	0.0109	149.47 ± 42.12	131.38 ± 33.56	-19.91	0.0130	155.50 ± 50.98	136.83 ± 24.29	-18.67	0.2235
Trig, mg/dl	128.27 ± 84.55	114.33 ± 46.57	-13.94	0.1673	121.90 ± 101.26	111.03 ± 60.31	-13.94	0.4256	129.17 ± 63.36	108.92 ± 44.42	-20.25	0.2288
HDL, mg/dl	50.23 ± 13.59	47.96 ± 10.55	-2.27	0.0989	44.66 ± 12.98	45.72 ± 11.31	-2.27	0.4901	44.00 ± 12.25	46.50 ± 13.43	2.50	0.3302
LDL, mg/dl	106.63 ± 46.25	87.12 ± 32.65	-19.51	0.0055	79.03 ± 34.64	63.19 ± 26.58	-19.51	0.0163	85.83 ± 48.74	68.58 ± 17.47	-17.25	0.1992
FBS, mg/dl	120.86 ± 47.09	118.18 ± 46.60	-2.68	0.7378	113.07 ± 32.70	116.19 ± 32.02	-2.68	0.6049	132.85 ± 40.41	126.23 ± 40.58	-6.62	0.6082
HbA1c, %	7.32 ± 2.03	6.99 ± 1.32	-0.33	0.4166	7.06 ± 1.68	6.57 ± 0.94	-0.33	0.3484	7.18 ± 1.00	6.94 ± 1.08	-0.24	0.4363
LVIDd, cm	5.42 ± 0.80	4.98 ± 0.60	-0.44	< 0.0000	5.31 ± 0.59	4.96 ± 0.68	-0.44	0.0012	5.19 ± 0.85	4.80 ± 0.54	-0.39	0.0873
LVIDs, cm	4.43 ± 0.97	3.57 ± 0.57	-0.86	< 0.0000	4.34 ± 0.88	3.70 ± 0.73	-0.86	< 0.0000	4.17 ± 0.87	3.50 ± 0.80	-0.67	0.0160
EF, %	29.82 ± 0.10	52.47 ± 0.08	22.65	< 0.0000	31.27 ± 7.13	51.00 ± 7.35	22.65	< 0.0000	30.92 ± 9.14	51.38 ± 7.93	20.46	< 0.0000

ISSN: 2378-2951

Table 3: Comparing the mean baseline and final measurements in Group B.

Group B (n = 31)				
	Baseline	**Final**		
Clinicals	**Mean (SD)**	**Mean (SD)**	Δ	**p-value**
HR, bpm	72.97 ± 12.39	74.87 ± 15.99	1.9	0.7045
Systolic BP, mmHg	127.07 ± 21.57	131.52 ± 22.58	4.45	0.4264
Diastolic BP, mmHg	73.73 ± 11.3	74.84 ± 15.12	1.11	0.7810
Weight, kg	90.28 ± 22.16	85.83 ± 26.35	-4.44	0.0832
BMI, kg/m^2	32.37 ± 14.92	28.84 ± 7.08	-3.53	0.1595
T. Chol, mg/dl	158.9 ± 38.56	139.43 ± 33.23	-19.47	0.0270
Trig, mg/dl	157.03 ± 183.32	105.39 ± 50.54	-51.64	0.1525
HDL, mg/dl	47 ± 16.2	47.71 ± 12.24	0.71	0.6937
LDL, mg/dl	83.6 ± 30.15	69.96 ± 28.94	-13.64	0.0277
FBS, mg/dl	125.26 ± 52.81	124.19 ± 35.26	-1.07	0.5608
HbA1c, %	7.19 ± 2.87	6.82 ± 0.94	-0.38	0.1431
LVIDd, cm	5.3 ± 0.71	5.64 ± 0.8	0.34	0.0059
LVIDS, cm	4.08 ± 0.7	4.75 ± 0.94	0.68	< 0.0000
EF, %	40.55 ± 12.89	28.71 ± 10.22	-11.84	< 0.0000

Table 4: Incidence of cardiomyopathy, use of medications and CRT.

	Group A (n = 101)		**Group B (n = 31)**	
Mean age	62 (37-95)		69 (40-95)	
Cardiomyopathy	**n**	**%**	**n**	**%**
NICM	55	54	11	35
ICM	33	33	17	55
Mixed cardiomyopathy	13	13	3	10
Medications				
Beta-blocker	92	91	28	90
ACEi/ARB	60	60	12	39
ARNI	23	23	8	26
Aldactone	30	30	4	13
SGLT2i	16	15	4	13
Hydralazine/Isordil	4	4	4	13
CRT				
CRT	5	5	0	0

ejection fraction (HRrEF) can be categorized in to two main groups - the group with genetic predisposition and the group with lifestyle related abnormalities [15]. Even some in the genetic predisposition group can benefit by lifestyle changes altering the epigenetic make up in improving heart function. The current management in HF is based on pharmacotherapy targeted at the neurohormonal abnormalities (the Hypothalamus-Pituitary-Adrenal axis - HPA, and the Renin-Angiotensin-Aldosterone System-RAAS) associated with myocardial dysfunction, but also myocardial dysfunction is due to a state of chronic inflammation with multitude of factors besides the neurohormonal alterations [9,16]. The inflammatory substrates have no effective medical treatment yet. But they can be improved with optimal lifestyle practices which include diet, exercise, weight control, abstinence from toxic chemicals, practice of appropriate sleep hygiene, and stress management [17]. Secondly, the current standard-of-care pharmacological approaches to HF provide symptomatic and clinical benefits by reducing workload on the heart instead of increasing its reserve where lifestyle changes will contribute by making cellular changes at molecular level [18].

Diet and nutrition

In the Cardiovascular Health status evaluation by the National Health and Nutrition Examination Survey

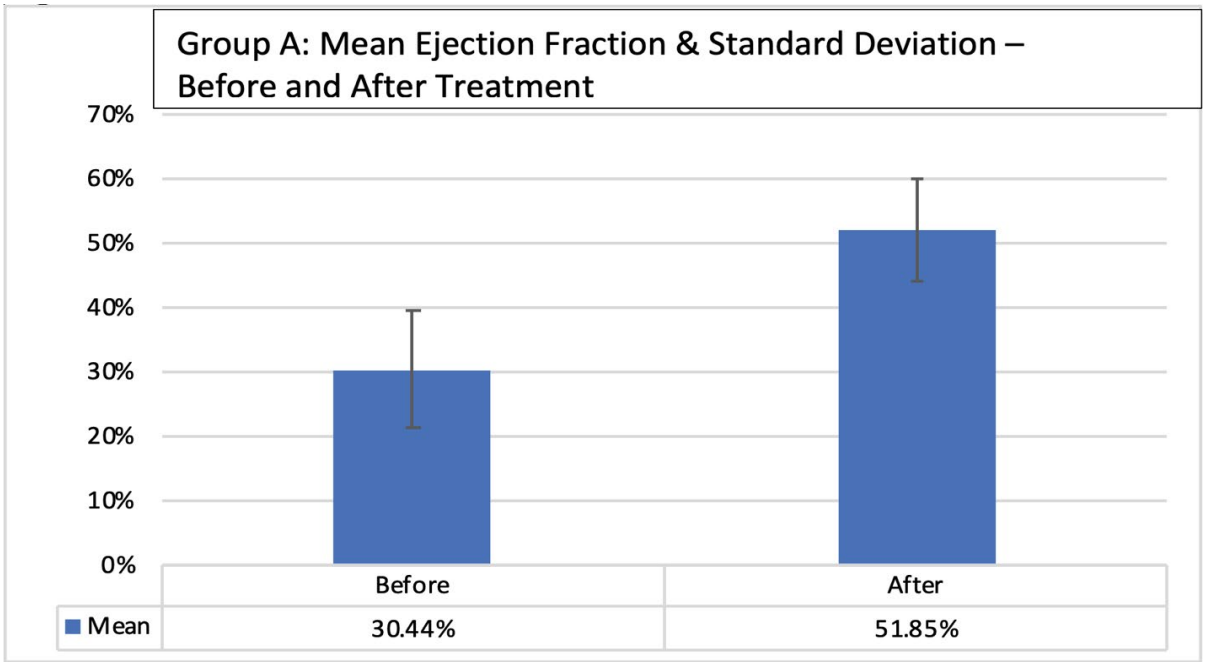

Figure 1: Group A: Mean ejection fraction & standard deviation - before and after treatment.

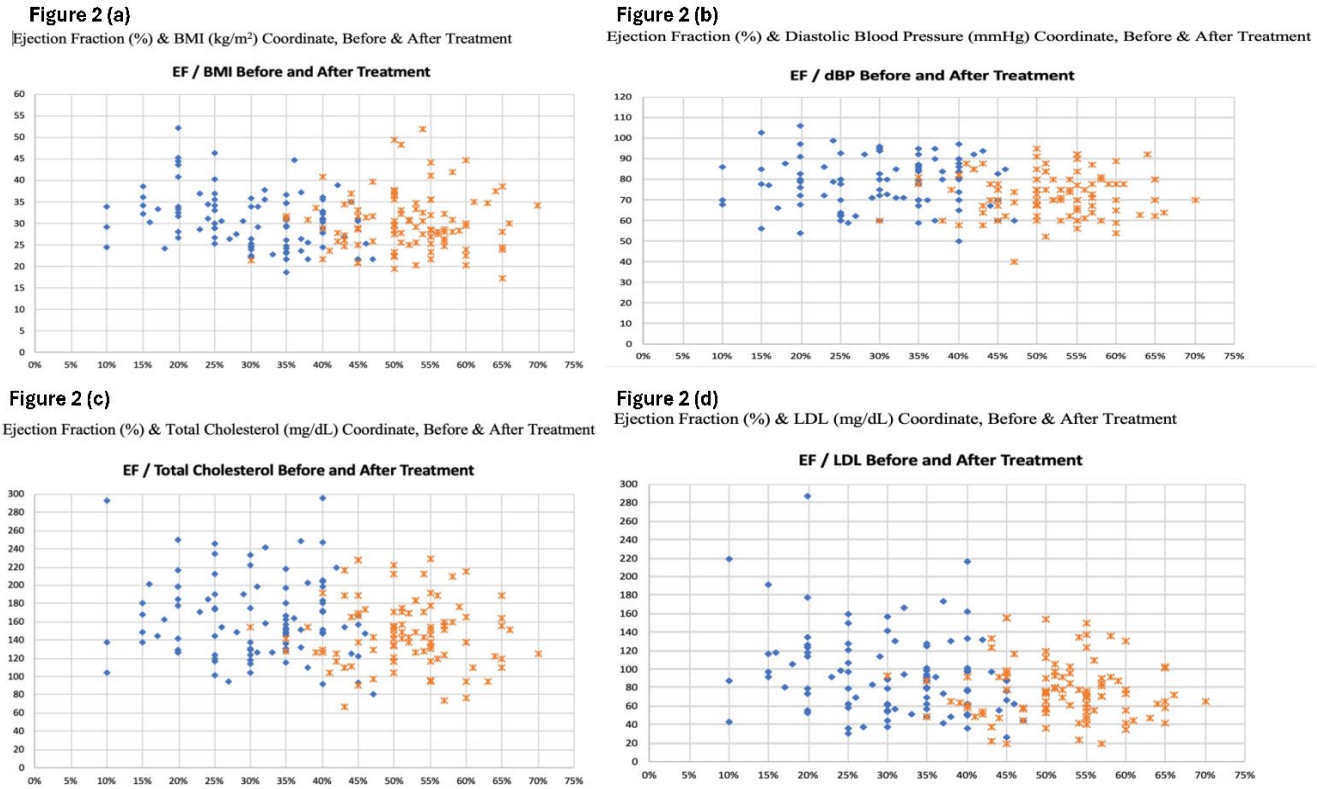

Figure 2: (a) Ejection fraction (%) & BMI (kg/m²) coordinate, before & after treatment; b) Ejection fraction (%) & diastolic blood pressure (mmHg) coordinate, before & after treatment; c) Ejection fraction (%) & Total cholesterol (mg/dL) coordinate, before & after treatment; (d) Ejection fraction (%) & LDL (mg/dL) coordinate, before & after treatment.

(NHANES) between 2013-2018 in US adults, by the scored analysis according to the Life's Essential 8 Metrics, it was found that only 36% percent of adult population has adopted a heart healthy dietary pattern [6]. Similarly, Baraldi, et al. have analyzed the data from the NHANES 2007-2012 period found that almost 60% of calories consumed came from ultra-processed foods and sugar containing drinks (UPFD) in the USA [19]. These studies have demonstrated that the dietary contribution of UPFD is inversely associated with low dietary content of protein, fiber, and most macronutrients, and are directly associated with high simple carbohydrate, saturated fat, total sugar, added sugar, and sodium content. An increase in dietary contribution of UPFDs have also been

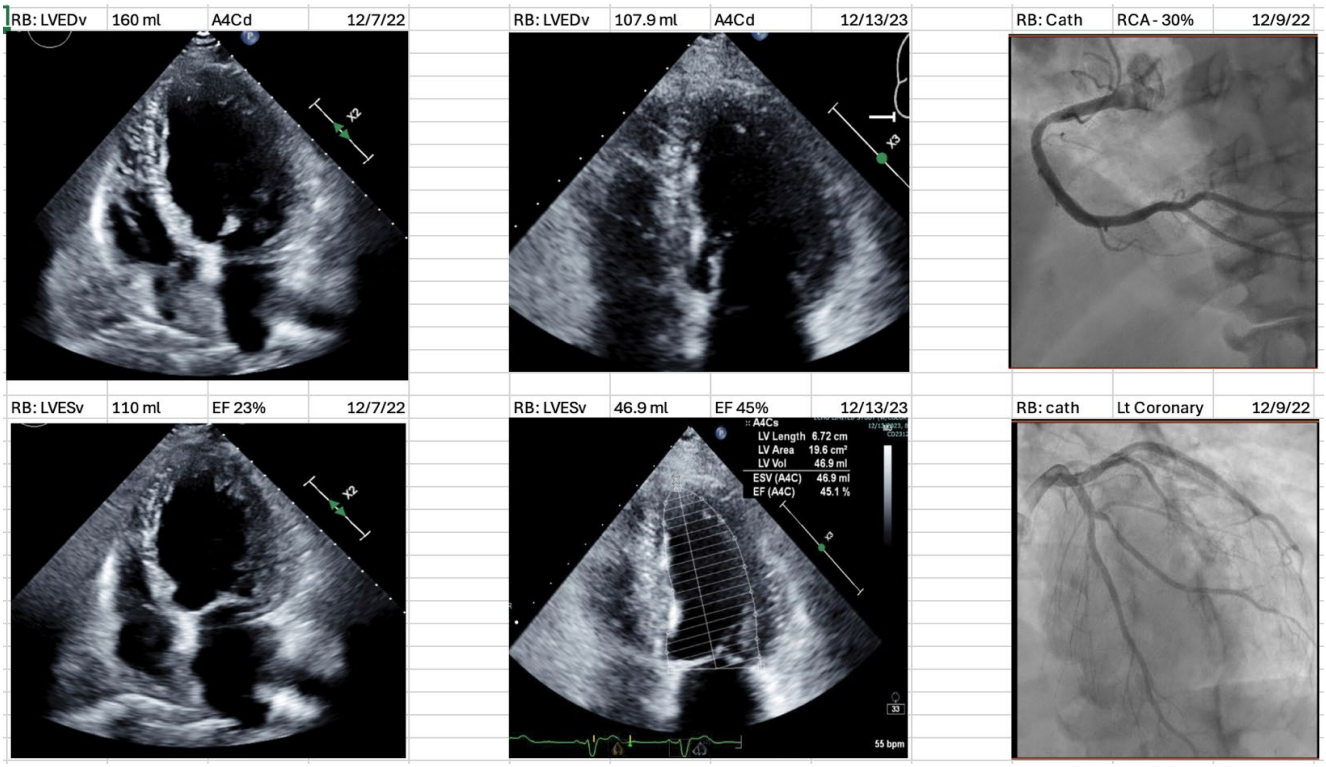

Figure 3.1: A case of nonischemic Cardiomyopathy (NICM).

Echocardiograms: Left panel- upper as baseline (before treatment) LVED volume in diastole and the left lower as LVED volume in systole; Middle panel- upper as final (after treatment) LVED volume in diastole and the lower middle in systole (apical 4C views).

Coronary angiograms: Upper right: RCA has 30% proximal narrowing. Lower right: The left coronary arteries have only minor narrowing.

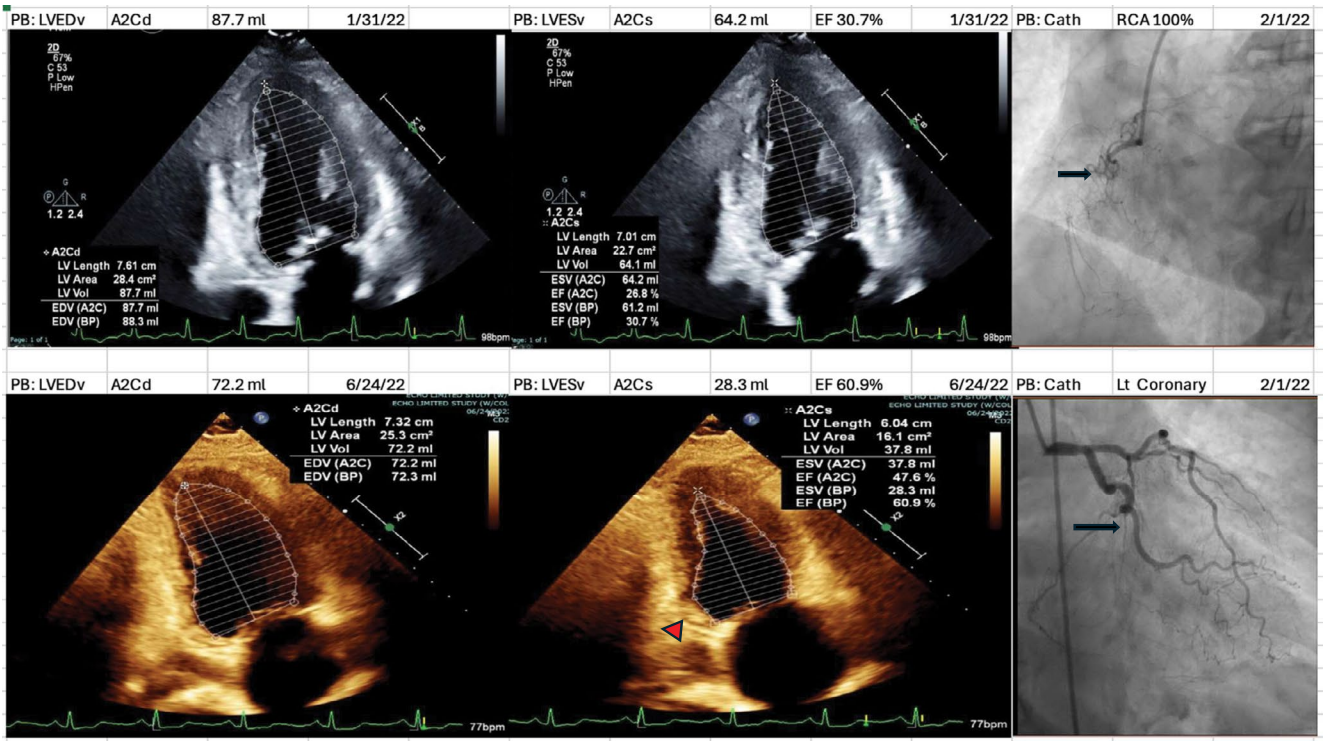

Figure 3.2: A case of ischemic cardiomyopathy (ICM).

Echocardiograms: Upper panel- baseline (before treatment) LVED volume in diastole and systole, and the lower panel are final (after treatment) LVED volume in diastole and systole (apical 2 chamber views); The red triangle indicates akinetic (infarcted) inferior-posterior left ventricular wall segment.

Coronary angiograms: Right upper- RCA 100% occluded is marked by the small black arrow; Right lower - Posterior circumflex is 99% occluded (diffuse disease) marked by the long black arrow.

associated with decrease in vitamins A, C, D, and E, zinc, potassium, phosphorus, magnesium and calcium [19]. Secondly, the adverse health effects of the additives present in the UPFD are vastly unknown. But the recent research publication on Xylitol (low-calorie sweetener) is found to be associated with major cardiovascular risks and is a cause of concern for the other additives which have not been meticulously studied [20].

Improving current dietary habits to a WFPBD will have profound and positive health benefits in consuming appropriate number of calories from the macro and micronutrients. In addition, it provides high-fiber, minerals, vitamins, antioxidants, and bioflavonoids which are essential to maintain good health - energy balance, metabolism, support the gut microbiome, and improve immunity [21,22].

Heart failure is a myocardial nutrition deficiency disease, and for its metabolic and functional recovery, the biochemical needs are met with WFPBD, which is nutritionally rich, and is low in saturated fat, low in salt, and low in (added) sugar, and has no cholesterol.

Exercise

Physical activity in patients with HFrEF has pleotropic benefits. At minimum moderate-intensity/vigorous-intensity exercise duration of 150/75 minutes per week are recommended [23]. In addition, resistance training at least two days a week has added benefits in maintaining muscle mass and muscle strength. According to the NAHANES 2013-2018 data, only 52% of adults meet the minimum requirement of physical activity to maintain heart health [6]. Exercise training leads to improvements in central hemodynamic status and peripheral vascular, endothelial, and skeletal muscle function, attenuation of sympathetic, increase in vagal tone, and decrease in the neurohormonal activation (reduction in renin, angiotensin, and aldosterone). Other benefits are - reduction in circulating levels of N-terminal pro-B-type natriuretic peptide, reduced inflammatory cytokines, decrease in insulin resistance, decrease in lipids and blood pressure. Recent studies in rats have elucidated the dynamics of the multi-omic response to endurance training demonstrating, at cellular level, in enriching carbohydrate metabolism, oxidative phosphorylation and increased mitochondrial biogenesis. Besides these intracellular improvements, it has also regulated extracellular structural remodeling in promoting physiologically beneficial adaptations [reverse remodeling] [24]. These are accompanied with improvements in left-ventricular end-diastolic and end-systolic dimensions and LVEF. In addition, these favorable changes are associated with improvements in quality of life, functional capacity, exercise performance, and in modest reduction of heart failure related hospitalization and cardiovascular mortality [25-27].

Restoring metabolic balance and impact of autophagy

Obesity [28,29], diabetes, hypertension, and hyperlipidemia are the result of a poor-quality diet and suboptimal practice of healthy lifestyle and are responsible for most of the chronic diseases in our society today including heart disease [5]. At cellular level, these lead to lipotoxicity, oxidative stress, and myocardial dysfunction [30-34]. These can be remedied by the adoption of healthy lifestyle practices, including a predominantly a plant-based diet [35-38].

Autophagy, the self-eating activity involved in the maintenance of cellular homeostasis, is currently a therapeutic target in several diseases, including heart failure. Enhancing autophagy with regular exercise and intermittent fasting (and/or time restricted eating) are promising strategies in improving cellular function thereby improving left ventricular function in heart failure [39]. Heart muscle requires perennial energy production and utilization. In this process, equally significant wear and tear of intracellular organelles, and excess toxic metabolic byproducts are generated. As a result, heart is a unique organ having dual mechanisms of autophagic process both intracellular (lysosome) and extracellular (material spilling over from the crowded intramyocellular compartment to extracellular space are cleared by the macrophages), to deal with these inflammatory byproducts, cellular debris, and importantly in recycling some of the essential components (proteins), thereby saving energy [40].

Tobacco, cannabis, and alcohol

Smoking cigarettes, cannabis, and drinking excess alcohol are all linked to heart failure. Cigarette smoking leads to vascular endothelial dysfunction and coronary artery disease a major cause for heart failure, myocardial infarction and cardiac arrhythmia. Cannabis has multiple effects in the cardiovascular system. Tetrahydrocannabinol (THC) stimulates the sympathetic system; increase heart rate, myocardial oxygen demand, supine blood pressure, and platelet activation; and associated with endothelial dysfunction and oxidative stress. Smoking cannabis regardless of THC content increase concentration of carboxyhemoglobin and tar. These lead to endothelial dysfunction, increased oxidation of lipoproteins leading to clinical presentations of cardiomyopathy, angina, myocardial infarction, arrhythmia, heart failure and sudden cardiac death [41]. Excess alcohol consumption combined with unhealthy diet leads to cardiomyopathy and heart failure [42,43]. The pathology of alcoholic cardiomyopathy involves a combination of direct toxic effects of alcohol on the myocardium, oxidative stress, mitochondrial dysfunction, and a genetic susceptibility. Ethanol and its metabolites can disrupt cellular processes, impair protein synthesis, and cause oxidative

stress leading to cellular injury and dysfunction within the heart muscle [44]. Moreover, there has been causal association between alcohol consumption and risk of hypertension, especially an alcohol intake of 12 g/d, and are consistent with recommendations to avoid or limit alcohol intake. Besides the direct myocardial toxicity of alcohol leading to cardiomyopathy, hypertension is also a major risk factor for developing cardiomyopathy [45]. On the other hand, abstaining from alcohol use and adhering to a healthy lifestyle as outlined in the "Life's Simple 7" will prevent and even reverse these serious health conditions.

Environmental stress- anxiety/depression

Environmental stress can lead to anxiety and depression. Chronic stress has been known to cause cardiovascular disease and other metabolic disorders mediated through activation of chronic inflammatory response by liberation of many cytokines - interleukin-1, IL-2, IL-4, tumor necrosis factor (TNF) alpha, and interferon (INF) alpha. These elements impair the function of the glucocorticoid receptor (GR) which is otherwise known as "glucocorticoid resistance". This in turn leads to excessive inflammation as well as hyperactivity of the corticotrophin releasing hormone and sympathetic system pathways. These ultimately contribute to variety of diseases and behavioral alterations responsible in perpetuating the process [46]. In a human genome-wide study, impaired transcription of glucocorticoid response genes and increased activity of pro-inflammatory transcription control pathways has provided a functional genomic explanation for elevated risk of inflammatory disease in individuals who experience chronically high levels of subjective isolation [chronic stress] [47]. It has been found that long-term meditation practices have prevented and reversed the stress related harmful health effects by epigenetic alterations and influencing the gene expression positively [48,49].

Circadian rhythm and sleep duration

The circadian rhythm is an evolutionary regulatory mechanism that influences the expression of human biology and physiology to maintain homeostasis for optimal bodily function. This collates three major activities - time restricted eating, ideally a window of 8 to 10 hours over 24 hours (that is fasting 16 and 14 hours respectively), energy generation for physiologic and physical activities, and restorative sleep for 7 to 8 hours daily (allows cellular metabolic recovery, repair, autophagy, and rejuvenation). These taken together and practice with regularity maintains the integrity of cellular and overall organ function, which is essential for optimal health [50-53].

Conclusion

Incorporating lifestyle practices to standard medical management has the complementary advantage in recovering left ventricular structure and function. These changes are accompanied with reduced weight, improved metabolism, reduction in inflammation, improvement in cardiovascular hemodynamics, and ultimately achieving favorable outcomes by reversing left ventricular remodeling, improving myocardial dynamics, and thereby improving LVEF.

References

1. Bozkurt B, Ahmad T, Alexander KM, Baker WL, Bosak K, et al. (2023) Heart failure epidemiology and outcomes statistics: A report of the heart failure society of America. J Card Failure 29: 1412-1451.
2. Shah KS, Xu H, Matsouaka RA, Bhatt DL, Heidenreich PA, et al. (2017) Heart failure with preserved, borderline, and reduced ejection fraction: 5-year outcomes. J Am Coll Cardiol 70: 2476-2486.
3. Agarwal MA, Fonarow GC, Ziaeian B (2021) National trends in heart failure hospitalizations and readmissions from 2010 to 2017. JAMA Cardiol 6: 952-956.
4. Volpp KG, Berkowitz SA, Sharma SV, Anderson CAM, Brewer LC, et al. (2023) Food is medicine: A presidential advisory from the American Heart Association. Circulation 148: 1417-1439.
5. Folsom AR, Shah AM, Lutsey PL, Roetker NS, Alonso A, et al. (2015) American Heart Association's Life's Simple 7: Avoiding heart failure and preserving cardiac structure and function. Am J Med 128: 970-976.e2.
6. Lloyd-Jones DM, Ning H, Labarthe D, Brewer L, Sharma G, et al. (2022) Status of Cardiovascular Health in US Adults and Children Using The American Heart Association's New "Life's Essential 8" Metrics: Prevalence Estimates From the National Health and Nutrition Examination Survey (NHANES), 2013 Through 2018. Circulation 146: 822-835.
7. Driggin E, Cohen LP, Gallagher D, Karmally W, Maddox T, et al. (2022) Nutrition assessment and dietary interventions in heart failure: JACC review topic of the week. J Am Coll Cardiol 79: 1623-1635.
8. Pischke CR, Weidner G, Elliot-Eller M, Ornish D (2007) Lifestyle changes and clinical profile in coronary heart disease patients with an ejection fraction of <or= 40% 0r > 40% in the multicenter lifestyle demonstration project. Eur J Heart Fail 9: 928-934.
9. Murphy SP, Kakkar R, McCarthy CP, Januzzi JL (2020) Inflammation in heart failure: JACC state-of-the-art review. J Am Coll Cardiol 75: 1324-1340.
10. Monteiro CA, Cannon G, Levy RB, Moubarac J-C, Lc Louzada M, et al. (2019) Ultra-processed foods: What they are and how to identify them. Public Health Nutr 22: 936-941.
11. Panigrahi G (2021) Coronary risk factors and its reduction by plant-based diet with emphasis on diabetes: A preliminary report. Int J Clin Cardiol 8: 216.
12. Panigrahi G (2023) Remission of Type 2 Diabetes with high-fiber, low-fat, and calorie restricted plant-based diet study. Int J Diabetes Clin Res 10: 167.
13. Mayerhofer CCK, Kummen M, Holm K, Broch K, Awoyemi A, et al. (2020) Low fiber intake is associated with gut microbiota alterations in chronic heart failure. ESC Heart Fail 7: 456-466.

14. Romano KA, Nemet I, Saha PP, Haghikia A, Li XS, et al. (2023) Gut microbiota-generated phenylacetylglutamine and heart failure. Circ Heart Fail 16: e009972.

15. Cabrera-Romero E, Ochoa JP, Barriales-Villa R, Bermúdez-Jiménez FJ, Climent-Payá V, et al. (2024) Penetrance of dilated cardiomyopathy in genotype-positive relatives. J Am Coll Cardiol 83: 1640-1651.

16. Mann DL (2002) Tumor necrosis factor-induced signal transduction and left ventricular remodeling. J Card Fail 8: S379-S386.

17. Aggarwal M, Bozkurt B, Panjrath G, Aggarwal B, Ostfeld RJ, et al. (2018) Lifestyle modifications for preventing and treating heart failure. J Am Coll Cardiol 72: 2391-2405.

18. Alnuwaysir RIS, Hoes MF, van Velhuisen DJ, van der Meer P, Beverborg NG (2022) Iron deficiency in heart failure: Mechanisms and pathophysiology. J Clin Med 11: 125.

19. Baraldi LG, Steele EM, Canella DS, Monteiro CA (2018) Consumption of ultra-processed foods and associated sociodemographic factors in the USA between 2007 and 2012: Evidence from a nationally representative cross-sectional study. BMJ Open 8: e020574.

20. Witkowski M, Nemet I, Li XS, Wilcox J, Ferrell M, et al. (2024) Xylitol is prothrombotic and associated with cardiovascular risk. Eur Heart J 45: 2439-2452.

21. Lara KM, Levitan EB, Gutierrez OM, Shikany JM, Safford MM, et al. (2019) Dietary patterns and incident heart failure in U.S. adults without known coronary disease. J Am Coll Cardiol 73: 2036-2045.

22. Rautiainen S, Levitan EB, Mittleman MA, Wolk A (2015) Fruit and vegetable intake and rate of heart failure: A population-based prospective cohort of women. Eur J Heart Fail 17: 20-26.

23. Singh R, Pattisapu A, Emery MS (2020) US physical activity guidelines: Current state, impact and future directions. Trends Cardiovasc Med 30: 407-412.

24. MoTrPAC Study Group (2024) Temporal dynamics of the multi-omic response to endurance exercise training. Nature 629: 174-183.

25. Bozkurt B, Fonarow GC, Goldberg LR, Guglin M, Josephson RA, et al. (2021) Cardiac rehabilitation for patients with heart failure. J Am Coll Cardiol 77: 1454-1469.

26. Tucker WJ, Fegers-Wustrow I, Halle M, Haykowsky MJ, Chung EH, et al. (2022) Exercise for primary and secondary prevention of cardiovascular disease: JACC Focus Seminar 1/4. J Am Coll Cardiol 80: 1091-1106.

27. Ventura-Clapier R, Mettauer B, Bigard X (2007) Beneficial effects of endurance training on cardiac and skeletal muscle energy metabolism in heart failure. Cardiovasc Res 73: 10-18.

28. Kenchaiah S, Evans JC, Levy D, Wilson PWF, Benjamin EJ, et al. (2002) Obesity and the risk of heart failure. N Eng J Med 347: 305-313.

29. Huynh K, Ayers C, Butler J, Neeland I, Kritchevsky S, et al. (2022) Association between thigh muscle fat infiltration and incident heart failure: The Health ABC Study. J Am Coll Cardiol 10: 485-493.

30. Birse RT, Bodmer R (2011) Lipotoxicity and cardiac dysfunction in mammals and Drosophila. Crit Rev Biochem Mol Biol 46: 376-385.

31. Sharma S, Adrogue JV, Golfman L, Uray I, Lemm J, et al. (2004) Intramyocardial lipid accumulation in the failing human heart resembles the lipotoxic rat heart. FASEB J 18: 1692-1700.

32. Ashrafian H, Frenneaux MP, Opie LH (2007) Metabolic mechanisms in heart failure. Circulation 116: 434-448.

33. Sack MN, Rader TA, Parks S, Bastin J, McCune SA, et al. (1996) Fatty acid oxidation enzyme gene expression is downregulated in the failing heart. Circulation 94: 2837-2842.

34. Aung N, Sanghvi MM, Piechnik SK, Neubauer S, Munroe PB, et al. (2020) The effect of blood lipids on the left ventricle: A mendelian randomization study. J Am Coll Cardiol 76: 2477-2488.

35. Kahleova H, Petersen KF, Shulman GI, Alwarith J, Rembert E, et al. (2020) Effect of a low-fat vegan diet on body weight, insulin sensitivity, postprandial metabolism, and intramyocellular and hepatocellular lipid levels in overweight adults: A randomized clinical trial. JAMA Netw Open 3: e2025454.

36. Kerley CP (2018) A review of plant-based diets to prevent and treat heart failure. Card Fail Rev 4: 54-61.

37. Choi EY, Allen K, McDonnough M, Massera D, Ostfeld RJ (2017) A plant-based diet and heart failure: Case report and literature review. J Geriatr Cardiol 14: 375-378.

38. Wawrzenczyk A, Anaszewicz M, Wawrzenczyk A, Budzynski J (2019) Clinical significance of nutritional status in patients with chronic heart failure - a systematic review. Heart Fail Rev 24: 671-700.

39. Kanamori H, Yoshida A, Naruse G, Endo S, Minatoguchi S, et al. (2022) Impact of autophagy on prognosis of patients with dilated cardiomyopathy. J Am Coll Cardiol 79: 789-801.

40. Nicolas-Avila JA, Lachuga-Vieco AV, Esteban-Martinez L, Sánchez-Díaz M, Díaz-García E, et al. (2020) A network of macrophages supports mitochondrial homeostasis in the heart. Cell 183: 94-109.e23.

41. Page RL 2nd, Allen LA, Kloner RA, Carriker CR, Martel C, et al. (2020) Medical marijuana, recreational cannabis, and cardiovascular health: A scientific statement from the American Heart Association. Circulation 142: e131-e152.

42. Ikram H, Maslowski AH, Smith BL, Nicholls MG (1981) The hemodynamic, histopathological and hormonal features of alcohol cardiac beriberi. Q J Med 50: 359-375.

43. Larsson SC, Burgess S, Mason AM, Michaelsson K (2020) Alcohol consumption and cardiovascular disease: A Mendelian Randomization Study. Circ Genom Precis Med 13: e002814.

44. Dominguez F, Adler E, Garcia-Pavia P (2024) Alcoholic cardiomyopathy: An update. Eur Heart J 45: 2294-2305.

45. Cecchini M, Fillipin T, Whelton PK, Iamandii I, Di Federico S, et al. (2024) Alcohol intake and risk of hypertension: A systemic review and dose-response meta-analysis of nonexperimental cohort studies. Hypertension 81: 1701-1715.

46. Pace TWW, Hu F, Miller AH (2007) Cytokine-effects on glucocorticoid receptor function: Relevance to glucocorticoid resistance and the pathophysiology and treatment of major depression. Brain Behav Immun 21: 9-19.

47. Cole SW, Hawkley LC, Arevalo JM, Sung CY, Rose RM, et al. (2007) Social regulation of gene expression in human leukocytes. Genome Biol 8: R189.

48. Wenuganen S, Walton KG, Katta S, Dalgard CL, Sukumar G, et al. (2021) Transcriptomics of long-term meditation

practice: Evidence for prevention or reversal of stress effects harmful to health. Medicina 57: 218.

49. Black DS, Cole SW, Irwin MR, Breen E, St Cyr NM, et al. (2013) Yogic meditation reverses NF-kB and IRF-related transcriptome dynamics in leukocytes of family dementia caregivers in a randomized controlled trial. Psychoneuroendocrinology 38: 348-355.

50. Lampert MA, Gustafsson AB (2018) Balancing autophagy for a healthy heart. Curr Opin Physiol 1: 21-26.

51. Scheer FAJL, Hu K, Evoniuk H, Kelly EE, Malhotra A, et al. (2010) Impact of the human circadian system, exercise, and their interaction on cardiovascular function. Proc Natl Acad Sci U S A 107: 20541-20546.

52. Gill S, Le HD, Melkani GC, Panda S (2015) Time-restricted feeding attenuates age-related cardiac decline in Drosophila. Science 347: 1265-1269.

53. Cappuccio FP, Cooper D, D'Elia L, Strazzullo P, Miller MA (2011) Sleep duration predicts cardiovascular outcomes: A systematic review and meta-analysis of prospective studies. Eur Heart J 32: 1484-1492.