The Heart Surgery Forum #2013-240
16 (6), 2013 [Epub December 2013]
doi: 10.1532/HSF98.2013240
Online address: http://cardenjennings.metapress.com

Clinical and Seasonal Variations of Nutritional Risk Screening in Patients Scheduled for Rehabilitation after Heart Surgery

Marko Boban,[1] Viktor Persic,[1] Zeljko Jovanovic,[2] Niksa Jr Drinkovic,[1] Milan Milosevic,[3] Alessandro Laviano[4]

[1]Department of Cardiology, University Hospital Thalassotherapia Opatija, Medical School University of Rijeka, Opatija, Croatia; [2]Department of Pharmacology, Medical School University of Osijek, Osijek, Croatia; [3]Department of Environmental and Occupational Health, Andrija Stampar School of Public Health, University of Zagreb, Zagreb, Croatia; [4]Department of Clinical Medicine, University La Sapienza, Rome, Italy

ABSTRACT

Background: Current knowledge on the pervasiveness of increased nutritional risk in cardiovascular diseases is limited. Our aim was to analyze the characteristics of nutritional risk screening in patients scheduled for rehabilitation after heart surgery. Prevalence and extent of nutritional risk were studied in connection with patients' characteristics and seasonal climate effects on weight loss dynamics.

Methods: The cohort included 65 consecutive patients with an age range of 25-84 years, 2-6 months after surgical treatment for ischemic or valvular heart disease. Nutritional risk screening was appraised using a standardized NRS-2002 questionnaire. Groups were analyzed according to a timeline of rehabilitation according to the "cold" and "warm" seasons of the moderate Mediterranean climate in Opatija, Croatia.

Results: Increased nutritional risk scores (NRS-2002) of >3 were found in 96% of studied patients. Mean NRS-2002 of patients was 5.0 ± 1.0, with a percentage weight loss history of 11.7% ± 2.2% (4.6-19.0). Risk was found to be more pronounced during the warmer season, with NRS-2002 scores of 5.3 ± 0.7 versus 4.8 ± 1.1 (P = 0.136) and greater loss of weight of 13.0% ± 3.2% versus 10.6% ± 3% (P = 0.005), respectively. Increased nutritional risk correlated significantly with creatinine concentrations (rho = 0.359; P = 0.034 versus 0.584; P = 0.001, respectively). Significant discordance in correlations was found between NRS-2002 and the decrease in left ventricle systolic function (rho correlation coefficient [rho-cc] = –0.428; P = 0.009), the increase in glucose concentrations (cc = 0.600; P < 0.001), and the decrease in erythrocyte counts (cc = –0.520; P = 0.001) during the colder season.

Conclusion: Increased nutritional risk was found to be frequently expressed in the course of rehabilitation after heart surgery. Although seasonal climate effects influenced the weight loss dynamics, the impact on reproducibility of NRS-2002 was clinically less important. Further studies on the connection of nutritional risk with composited end points might offer improvements in overall quality of treatment.

Received August 21, 2013; accepted November 27, 2013.

Corresponding author: Dr. Marko Boban, Department of Cardiology, University Hospital Thalassotherapia Opatija, Medical School University of Rijeka, Opatija, Croatia (e-mail: marcoboban@yahoo.com)

INTRODUCTION

A high percentage of malnourishment continues to be found among hospitalized and institutionalized patients [Gallagher-Allred 1996]. Furthermore, surgical patients are more prone to malnutrition, and surgery per se is associated with elevated metabolic requirements due to increased stress, disease severity, intensive care treatment, and reparatory and inflammatory processes as well as wound healing [Mechanick 2004]. The overall prognosis in malnourished patients is relatively inferior to that of peers with a similar disease stage or intensity but with normal nutritional status [Sorensen 2009]. Hospitalizations were found to be more frequent and of prolonged time durations solely on the basis of nutritional status [Pirlich 2006]. Greater disease prevalence and treatment-related complications have been observed to occur due to nutritive deficiencies. Rehabilitation potential and exercise capacity were also found to be negatively correlated with the presence of malnutrition [Shinchuk 2007].

Preoperative nutritional status and cardiologic disease severity was likewise found to affect major health-related outcomes [DiMaria-Ghalili 2002]. Patients treated by cardiovascular surgery are especially vulnerable to developing nutritional risks during the subsequent rehabilitation. The population of patients who are undergoing secondary prevention procedures are generally of middle to advanced age, have diminished reparatory potential, and suffer functional deficits of several organs. These deficits principally include diffuse atherosclerotic ischemia, chronic kidney disease, diabetes, cigarette smoking, and chronic obstructive pulmonary disease [Anker 2003]. Declines in metabolism and physiology in combination with decreased functional reserves make this population more prone to involuntary weight loss and associated greater morbidity and mortality [Wedick 2002].

Metabolism and body weight changes are in some part modulated externally through climate effects, predominantly outer temperature, dietary changes, and daily light hours. Studies on prevalence; dynamics, and clinical course of nutritional risk screening or relations to seasonal variations are scarce. Our aim was to analyze unintentional weight loss and nutritional risk screening in patients on rehabilitation subsequent to heart surgery. Assessments were done in relation to cardiovascular condition, comorbidities, diagnostic procedures, and seasonal climate effects.

PATIENTS AND METHODS

Study Course

The study was a noninterventional, prospective, nonrandomized cohort, performed in a high-throughput specialized national medical center. The study population included white adults of European and Middle Eastern origin at the beginning of a cardiovascular rehabilitation program in the timeline of 1-6 months after completing surgical treatment for ischemic or valvular heart disease. Relevant medical history was available and included for the entire study population. The clinical checkup included specialist examinations, anthropometrics, laboratory tests, transthoracic echocardiography, and nutritional risk screening. Study protocol included routine cardiovascular reevaluation and there was no follow-up. For the purposes of this study, consecutive sets of patients were grouped in bimodal way according to the commencement of rehabilitation program in the "cold" or "warm" season of the moderate Mediterranean climate settings in Opatija, Croatia (coordinates: 45°20′N 14°18′E). The cold season included the timeline from October 2011 to March 2012 and the warm season from April 2011 to September 2011. The reported differences in the climate settings for the studied seasons had a mean monthly temperature delta of 13°C and 9 versus 15 hours of daylight. The group of patients with established nutritional risk was analyzed separately. Study patients with acute contraindications for cardiac rehabilitation, such as a severe acute illness or an unregulated chronic disorder at an advanced stage (particularly known and disseminated neoplasms, severe thyroid hormone imbalances, or decompensated heart failure) or with a surgical treatment timeline beyond the period of 6 months were not included in this study.

Main Outcome Measures

Anthropometrics: Weight and height were measured at the beginning of rehabilitation, and body mass index (BMI) was calculated (in kg/m^2) using the customary formula. The percentage weight lost history (%WLH) was expressed as the percentage of lost kilograms to baseline, i.e., preoperative weight. Data on preoperative body weight were available from medical documentation for 85% of patients. The remaining 15% of unrecorded data were reported by the patients themselves in 6 cases, and 4 patients could not report with certainty their baseline weight. Waist circumference (WC), hip circumference (HC), and waist-hip ratio (WHR) were measured in centimeters. Body composition was analyzed indirectly by handheld bioelectrical impedance using the tetrapolar electrode method using 8 touch electrodes (frequency range 5, 50, and 250 kHz) and expressed in percentages (%).

Nutritional risk screen: The nutritional risk score was calculated using the standardized nutritional risk score (NRS-2002) screening tool validated by the European Society for Clinical Nutrition and Metabolism (ESPEN) [Kondrup 2003]. Screening includes summation of percentage and timeline of nondeliberate weight loss (scored on a scale ranging from 1 to 3 points) and relative disease severity (range 1 to 3 points) plus 1 additional point if the patient is over the age of 70 years. Usual outcomes are in range 0-7, and values over 3 are considered as clinically significant nutritional risk.

Cardiovascular Diagnostics

Laboratory diagnostics: Samples were taken from cubital vein of fasting patients during the morning hours of 07:30-08:30. Analyzes included complete blood count (CBC), biochemistry, and thyroid-stimulating hormone.

Transthoracic echocardiography: Exams were done on a Toshiba Artida with a PST30BT 3-MHz cardiology transducer. Studies were performed by 2 experienced high-throughput cardiologists using methodology standardized by the European Association for Echocardiography.

Other diagnostics: Standard supine resting electrocardiogram (ECG) with assessment of heart rate and rhythm in terms of sinus or atrial fibrillation was performed in all patients. Pulmonary status and chronic obstructive pulmonary disease prevalence and intensity were evaluated with a spirometer and expressed as the forced expiratory volume in 1 second (FEV1)/forced vital capacity (FVC) ratio, ie, the Tiffneau index.

Ethical Issues

This study was approved by the University Hospital's ethics committee. Patients were included after signing written informed consent. Both patients and authors who engaged in this study did not receive commercial financial compensations in any way.

Statistical Analyses

Populations and studied groups were analyzed with descriptive statistic and presented as means and medians, combined with standard deviation (SD) or interquartile range. Weight changes and diagnostic test reports were presented as medians with overall interval ranges in order to reduce the outlier effects. Population demographics, comorbidities, and nutritional risk score outcomes within studied groups were calculated with Mann-Whitney, Kruskal-Wallis, or Pearson chi-square tests. Correlation of NRS-2002 score with cardiovascular diagnostic outcomes was done by Spearman's rho, and the significantly most discordant results between seasonal groups are presented in diagrams. *P* values of < 0.05 were considered significant. Statistical analyses were done by a professional statistician using IBM SPSS version 19 (SPSS, Chicago, IL, USA).

Table 1. Characteristics of Patients (N = 65) and Studied Groups

	Cold, n (%)	Warm, n (%)	Chi square	Total, n (%)
Sex				
Male	31 (86.1%)	21 (72.4%)	0.170	52 (80.0%)
Female	5 (13.9%)	8 (27.6%)		5 (20.0%)
Age groups, years				
<45	2 (5.6%)	1 (3.4%)	0.829	3 (4.6%)
45-64	15 (41.7%)	14 (48.3%)		29 (44.6%)
>65	19 (52.8%)	14 (48.3%)		33 (50.8%)
Treatments				
CABG	24 (68.6%)	24 (80.0%)	0.130	48 (73.8%)
Valvular heart surgery	11 (31.4%)	6 (20.0%)	0.368	17 (26.2%)
Left ventricle ejection fraction				
<40%	3 (8.1%)	4 (14.3%)	0.002	7 (10.8%)
40%-49%	7 (18.9%)	15 (53.6%)		22 (32.3%)
>50%	27 (73.0%)	9 (32.1%)		36 (55.4%)
Arterial hypertension	34 (94.4%)	27 (93.1%)	0.823	61 (93.8%)
Hyperlipoproteinemia	32 (88.9%)	29 (100.0%)	0.064	61 (93.8%)
Chronic renal disease	16 (44.4%)	14 (48.3%)	0.758	30 (46.2%)
Diabetes mellitus	15 (41.7%)	11 (37.9%)	0.760	26 (40.0%)
Glucose intolerance	6 (16.7%)	5 (17.2%)	0.951	11 (16.9%)
Metabolic syndrome	26 (72.2%)	27 (93.1%)	0.031	53 (81.5%)
Any psychological distrubance	13 (36.1%)	9 (31.0%)	0.667	22 (33.8%)
Known coronary artery disease	27 (75.0%)	27 (93.1%)	0.053	54 (83.1%)
Past myocardial infarction	23 (63.9%)	22 (75.9%)	0.298	45 (69.2%)
Atherotrombotic disease	6 (16.7%)	5 (17.2%)	0.951	11 (16.9%)
Atrial fibrillation	4 (11.1%)	3 (10.3%)	0.921	7 (10.8%)
Chronic obstructive pulmonary disease	10 (27.8%)	4 (13.8%)	0.173	14 (21.5%)
Nicotine history				
Nonsmoker	13 (36.1%)	15 (51.7%)	0.444	28 (43.1%)
Active smoker	6 (16.7%)	4 (13.8%)		10 (15.4%)
Former smoker	17 (47.2%)	10 (34.5%)		27 (41.5%)

*Cold season, October to March; warm season, April to September. Groups tested with Chi square and considered significant if $P < 0.05$.

Table 2. Anthropometrical Data and Results of the NRS-2002 Screening Assessments

	Season		
	Cold, mean ± SD	Warm, mean ± SD	Mann-Whitney *U* Test
Age, years	64.7 ± 12.1	65.2 ± 10.8	0.958
Height, m	1.71 ± 0.15	1.69 ± 0.09	0.115
Weight, kg	84.8 ± 15.5	79.5 ± 12.9	0.164
BMI, kg/m^2	27.9 ± 3.5	27.6 ± 4.6	0.651
WC, cm	100.8 ± 10.3	95.9 ± 9.8	0.070
HC, cm	103.7 ± 7.1	99.9 ± 12.0	**0.017**
WHR, n/n	1.0 ± 0.1	1.0 ± 0.1	0.465
Bioelectrical impedance analyses–adipose tissue share, %	27.6 ± 7.2	28.4 ± 8.1	0.882
WLH, kg	8.9 ± 2.4	10.0 ± 1.8	**0.040**
%WLH	10.6 ± 3.1	13.0 ± 3.2	**0.005**
NRS-2002	4.8 ± 1.1	5.3 ± 0.7	0.136

*Cold season, October to March; Warm season, April to September. Results considered significant with $P < 0.05$ on the Mann-Whitney test.

RESULTS

Patients

Sixty-five (n = 65) consecutive patients were scheduled for rehabilitation during the timeline of 1-6 months after open chest heart surgery. There were 53 coronary artery bypass graft (CABG) operations for ischemic heart disease and 17 surgical procedures for primary valvular disorders. Valvular surgeries were accompanied by CABG in 5 cases with present coronary artery disease.

The mean age of the patients was 64.9 ± 11.4 years, without significant differences between the cold-season group (64.7 ± 12.1 years) and the warm-season group (65.2 ± 10.8) (P = 0.958). There also were no significant differences between the studied season groups for the other studied parameters. Patient characteristics are presented in Table 1. The NRS-2002 risk screen was analyzed in relation to patient characteristics, anthropometrics, cardiovascular status, comorbidities, and earlier treatments. Anthropometrical data and NRS-2002 screening results are presented in Table 2.

Variations in the percentages of weight loss history and NRS-2002 scores in relation to study patient characteristics are presented in Table 3.

There were no statistically significant differences (Mann-Whitney) between the studied seasons in regard to the usual clinical diagnostic parameters, including: complete blood count, biochemistry, spirometer analyses, ECG-detected rhythm abnormalities, and heart rate. Echocardiographic exams were a link between the cold and the warm seasons in all studied measurements except the left-ventricle end systolic dimension (31 mm [interquartile range 25.25-35.00 mm]) versus 37.50 (interquartile range 33.00-40.25; P = 0.010) and Doppler profile of early (E) mitral flow (0.81 [interquartile range 0.68-0.99]) versus 0.67 (interquartile range 0.54-0.86; P = 0.050), respectively. Conventional laboratory diagnostics, spirometer tests, echocardiography, and ECG (prevalence of atrial fibrillation and heart rate) did not reveal any seasonal differences of clearly pathological ranges or higher specificity. Seasonal dynamics of NRS-2002 were found to be associated with conventional cardiovascular diagnostics, displaying significantly discordant correlation rates for erythrocyte counts (rho = –0.520; P = 0.001 versus 0.017; P = 0.930), hematocrit (rho = –0.394; P = 0.019 versus –0.014; P = 0.941), mean corpuscular volume (rho = –0.394; P = 0.019 versus 0.014; P = 0.941), serum glucose concentration (rho = 0.600; P < 0.001 versus 0.278; P = 0.144), bilirubin (rho = 0.149; P = 0.392 versus 0.392; P = 0.035), urea (rho = 0.486; P = 0.003 versus 0.508; P = 0.005), creatinine (rho = 0.359; P = 0.034 versus 0.584; P = 0.001), thyroid stimulatory hormone (rho = 0.076; P = 0.664 versus 0.393; P = 0.038), left ventricle ejection fraction (rho = –0.428; P = 0.009 versus 0.044; P = 0.822), and transmitral Doppler flow profiles (early/late [E/A] ratio) (rho = –0.124; P = 0.529 versus –0.441; P = 0.024), respectively. The most noteworthy discordances of correlations are shown in the figure. Correlations of NRS-2002 with its inputs were of similar significance for both of the studied periods (cold versus warm season); patient age (rho = 0.720; P < 0.001 versus correlation coefficient [cc] = 0.678; P < 0.001), %WLH (rho = 0.535; P = 0.001 versus rho = 0.600; P = 0.001) respectively. BMI showed significant, yet intermediate, correlation with NRS-2002 within the warm season, and was not significant during the cold season (rho = –0.400; P = 0.032 versus rho = –0.086; P = 0.625). There were no significant correlations with anthropometrical circumferences or their ratios, bioelectrical impendence, or spirometer, or with ECG (frequency and rhythms) diagnostics.

Table 3. Variations of %WLH and NRS-2002 Score in Relation to Patient Characteristics

	%WLH, mean ± SD	Kruskal Wallis	NRS2002, mean ± SD	Kruskal Wallis
Age groups, years	7.4 ± 3.4	0.008	3.3 ± 1.5	<0.001
<45	10.9 ± 3.0		4.4 ± 0.8	
45-64	12.8 ± 3.2		5.7 ± 0.5	
>65				
Sex				
Male	11.4 ± 3.2	0.198	4.9 ± 1.1	0.421
Female	12.7 ± 3.9		5.3 ± 0.5	
BMI grade, kg/m^2				
<25	14.6 ± 3.3	0.012	5.5 ± 0.9	0.057
25-30	11.1 ± 3.2		4.8 ± 1.0	
30-35	10.8 ± 2.3		5.1 ± 0.8	
>35	7.0 ± 1.1		4.0 ± 1.4	
Left ventricle ejection fraction				
<40%	13.3 ± 2.6	0.136	5.3 ± 0.8	0.647
40%-49%	12.2 ± 3.4		5.1 ± 0.7	
>50%	10.9 ± 3.2		4.9 ± 1.1	
Treatments				
CABG	12.2 ± 3.0	0.116	5.1 ± 0.8	0.396
Valvular heart surgery	10.5 ± 3.7		4.9 ± 1.3	
Comorbidity				
Atherothrombotic disease	13.7 ± 3.2	0.037	5.4 ± 0.5	0.304
Past myocardial infarction	12.5 ± 3.0	0.041	5.2 ± 0.7	0.038
Chronic renal disease	12.1 ± 3.3	0.438	5.4 ± 0.6	0.018
Diabetes mellitus	13.0 ± 3.0	0.007	5.3 ± 0.6	0.055
Chronic obstructive pulmonary disease	10.7 ± 2.3	0.225	4.9 ± 0.9	0.571

Significance was tested with the Kruskal-Wallis test, using $P < 0.05$. Differences of %WLH and NRS-2002 according to comorbidities were tested for significance on the basis of the existence of comorbidity versus the rest of the group.

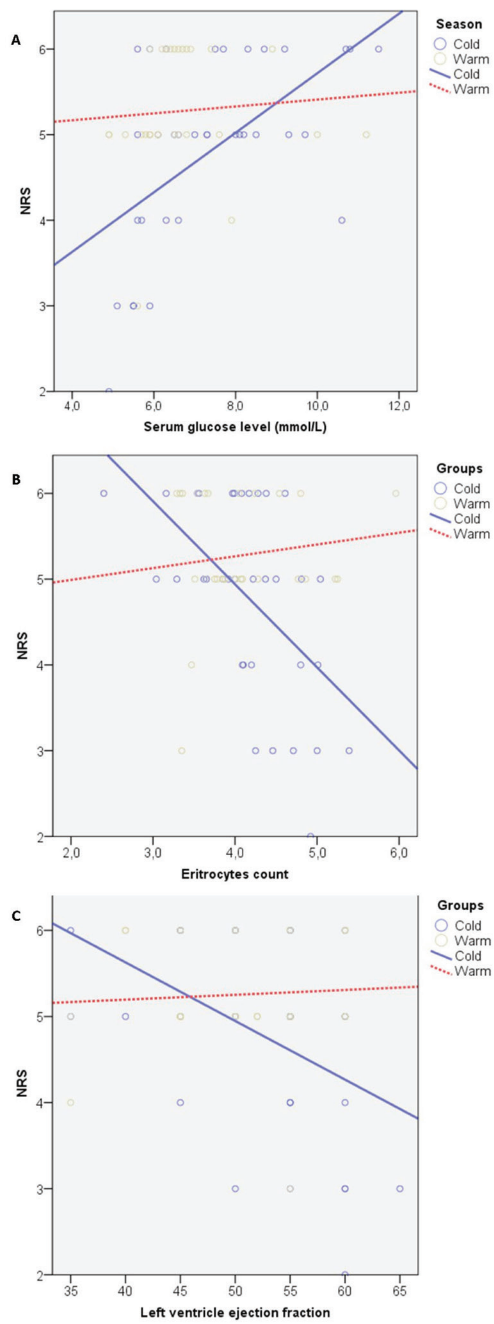

Figure 1. Serum glucose concentrations (mmol/L) (A), erythrocyte count (multiplied by 10^{12}) (B), and left ventricle ejection fraction (%) (C) correlations with NRS-2002 score results for the studied groups. A, Significant seasonal discordance in Spearman rho correlation between NRS-2002 nutritive risk and the increase in glucose concentrations (cc = 0.600; $P < 0.001$). B, Significant seasonal discordance in Spearman rho correlation between NRS-2002 nutritive risk and the decrease in erythrocyte counts (cc = −0.520; $P = 0.001$). C, Significant seasonal discordance in Spearman rho correlation between NRS-2002 nutritive risk and the decrease in left ventricle systolic function (rho-cc = −0.428; $P = 0.009$).

DISCUSSION

Although most of the patients in postoperative cardiovascular rehabilitation display increased long-term cardiovascular risk, transitory nutritional risk, however significantly amplified, might serve as an inconspicuous comorbidity that negatively influences the overall treatment results, including functional performance, cognitive profile, and quality of life [Wirth 2011]. Reports on the prevalence and extent of nutritional risk in patients with cardiovascular diseases are scarce, despite their tremendous health burden. An earlier study by van Venrooij et al. demonstrated the connection of clinical outcomes with nutritional status of patients preeceding the heart surgery [van Venrooij 2011]. Our study addressed for the first time nutritional risk screening in cardiovascular rehabilitation of patients after heart surgery and in its relation to seasonal climate effects.

The studied cohort of patients experienced mean weight loss history of 11.7% ± 3.3% in the late postoperative course of several months. No crucial differences were found between the types of surgeries, although coronary bypass revascularizations had more pronounced effects on the nutritional risk screening outputs. Later might be related with more advanced atherosclerotic process and decreased systolic function [Sorensen 2009]. Clinically significant weight loss was observed within groups of percentage weight loss and the timeline of changes, supporting the necessity of routine as well as repetitive assessments. Both inputs were shown to be easily available and reproducible input for nutritional risk screening with NRS-2002 in everyday practice [Kyle 2006].

Our patients as a rule displayed high risk scores by NRS-2002 screening tool during scheduled cardiovascular rehabilitation program [Sanchez 2011]. Variations in results of screening were found to be related to patient age, preservation of systolic function, and presence of comorbidities, similar to the extent within the percentage weight loss analyses. In general, substantial differences in in NRS-2002 outputs in relation to the type of previous surgical procedure were not observed, although this could be partially due to the inclusion of a relatively stable set of patients, as well as season-independent characteristics of the core process. Patients with a normal body type within the study timeline were more prone to greater mean NRS-risk, apart from overweight and obese, although there were no significant differences in correlations between NRS-2002 scores and BMI.

Patients with very pronounced grades of nutritional risk were individuals of advanced age and those with known medical histories of complicated atherosclerotic processes. Composited combinations of cardiovascular risk factors were associated with overall increases in nutritional risk through parameters of disease severity and greater recorded weight loss [Kondrup 2003]. It was previously shown that atherosclerotic endothelial dysfunction is related to impaired arterial stiffness and generally related to increased NRS risk [Sorensen 2009].

Significant correlations and coherent associations with nutritional risk were found in relation to chronic renal disease. Decline in renal function acted as an independent nutritional risk with a pronounced effect on loss of weight of 12.1%, with no meaningful seasonal differences. Conventional anthropometrics within studied ranges were not found to be significantly related to nutritional risks. Rather than having increased nutritional risk rates, patients in our settings were for the most part obese and overweight [Kastorini 2012]. Interestingly, even the youngest age at operation did not offer any substantial protection from developing nutritional risk factors during the postoperative cardiac rehabilitation period.

Significant differences were observed in several clinical parameters with respect to nutritional status between the seasons. A greater extent of nutritional risk was found during the warmer season due to recorded weight loss along with attainment of the highest grades in the NRS-2002 scoring system. Patients hospitalized during this part of the year showed greater median weight loss, probably because of the effect of the increase in external climate temperatures on loss of appetite combined with the operation-induced catabolic state [Laviano 2005]. Although the roles of secondary messengers within reparatory, immunological, and inflammation processes are not unanimously defined, acute-phase responses also seem to be dependent in part on changes within intermediary metabolism and nutrition factors [Jayarajan 2011]. Despite the limitations of the study population, seasonal differences in metabolic homeostasis were found in terms of greater prevalence of metabolic syndrome during the warmer time of year [Shahar 1999]. Later differences were shown to act independently of glucose metabolism and diabetes, which were similarly expressed during the 2 time periods. We noted a positive correlation of bilirubin concentrations during warmer season, as reported earlier; however, the effect at this time point was found to be connected with alternations in nutritional risk [Miyake 2009]. Positive correlations of thyrotrophic hormone concentration were found in relation to increased nutritional risk, which may have been due to differences in external temperature and quantity of daylight hours or an unspecific add-on effect associated with surgery-induced changes in metabolic responses [Hanon 2008]. Several reasons may account for significant seasonal changes in laboratory diagnostic results; however, we considered these to be unspecific metabolic responses. Interestingly, reversal dynamics were not observed outside the studied parameters during the colder part of the year. However, the revealed differences were of limited clinical discriminative value because alternations were within narrow output ranges that were close to physiological values. For echocardiography there were no other warm-enhanced changes in function or morphology apart from minor correlation with rates of early versus late atrial filling in Doppler profiles. In terms cardiovascular risk factors and comorbidities, this result may indicate a potentially independent effect on diastolic heart function [Shahar 1999].

During the cold season we observed curious reactive effects with several diagnostic tools, along with decreased catabolic effects, lower nutritional risk scores, and decreased weight loss. NRS-2002 outcomes were found to be positively correlated to glucose concentrations. This result might be consequence of advanced postoperative catabolic liver and muscle gluconeogenesis, because the prevalences of glucose intolerance and diabetes were of similar ranges [Laviano 2005]. Significant negative correlations were found in relation to increases in nutritional risk to red blood cell populations through both erythrocyte counts and indexes. Changes due to observed divergent correlations of erythrocyte counts to corpuscular volume point toward malnutrition effects and less efficient erythropoiesis during the colder season. This consequence might also be due to vitamin D deficiency and shorter daily light during winter [McGillivray 2007]. More advanced nutritional risk during the colder season was shown to be negatively correlated with left ventricle ejection fraction, which has not been previously described, although this could be associated in part with atherosclerotic complications [Gu 2008]. Greater prevalence of heart arrhythmias was previously observed during winter seasons; however, data on the relationship with left ventricle function, decompensation, and the success of heart surgery have not led to coherent conclusions [Ogawa 2007]. Rates of atrial fibrillations in our sample did not show seasonal characteristics. From the existing data it seems valuable to identify and quantify additional factors associated with the NRS-2002 input regarding chronic disease severity.

In our cohort, the ranges of prevalence of the most common cardiovascular risk factors, particularly the modifiable cluster, were similar to those in the national population of patients with coronary disease reported by the EUROASPIRE III study group [Kotseva 2009]. The prevalence of overweightness and obesity (76.9% of studied patients) was of a similar range as that previously reported for coronary patients in Croatia [Vrazic 2012]. It should not be disregarded that the population sizes in our study set important boundaries for more detailed analyzes. There are substantial challenges for the eventual diversification of the data to assess different temporal stages of cardiovascular disease, combined effects of common cardiovascular comorbidities, and risk factors. Despite the interesting and perplexing connections of cardiovascular diseases and clinical nutrition revealed by our study, one must not disregard analogous limitations in regard to the dynamics of unintentional weight loss and nutritional risk screening, as well as the seasonal climate effects. These are particularly challenging issues, due to the fact that beyond the size of the study population, the observed dynamics could be reserved both geographically and ethnically [Alberti 2009]. The composited effects of increased nutritional risk on obesity, metabolic syndrome, and diabetes have yet to be addressed within controlled interventional settings and with larger study populations.

CONCLUSIONS

In conclusion, increased nutritional risk was found to exist in most of patients scheduled for stationary rehabilitation after heart surgery. Although the weight loss displayed seasonal dynamics, this effect did not influence the clinical reproducibility of nutritional risk screening according to NRS-2002. The NRS-2002 results mostly did not correlate with traditional anthropometrically based risks, hence the necessity of periodic nutritional risk screening in cardiovascular patients, especially in circumstances of surgical treatment. Further studies on the connection of nutritional risk with composited end points might lead to improved understanding of the cardiovascular disease continuum and overall quality of treatment.

ACKNOWLEDGMENTS

We thank the personnel of the UHC "Thalassotherapia Opatija" who were involved in the care of the study patients.

REFERENCES

Alberti KG, Eckel RH, Grundy SM, et al. 2009. Harmonizing the metabolic syndrome: a joint interim statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity. Circulation 120:1640-5.

Anker SD, Negassa A, Coats AJ, et al. 2003. Prognostic importance of weight loss in chronic heart failure and the effect of treatment with angiotensin-converting-enzyme inhibitors: an observational study. Lancet 361:1077-83.

DiMaria-Ghalili RA. 2002. Changes in nutritional status and postoperative outcomes in elderly CABG patients. Biol Res Nurs 4:73-84.

Gallagher-Allred CR, Voss AC, Finn SC, McCamish MA. 1996. Malnutrition and clinical outcomes: the case for medical nutrition therapy. J Am Diet Assoc 96:361-366, 369; quiz 367-8.

Gu Y, Cheng LT, Chen HM, et al. 2008. Strong association between nutritional markers and arterial stiffness in continuous ambulatory peritoneal dialysis patients. Blood Purif 26:340-6.

Hanon EA, Lincoln GA, Fustin JM, et al. Ancestral TSH mechanism signals summer in a photoperiodic mammal. Curr Biol 18:1147-52.

Jayarajan S, Daly JM. 2011. The relationships of nutrients, routes of delivery, and immunocompetence. Surg Clin North Am 91:737-753, vii.

Kastorini CM, Panagiotakos DB. 2012. The obesity paradox: methodological considerations based on epidemiological and clinical evidence-new insights. Maturitas 72:220-4.

Kondrup J, Rasmussen HH, Hamberg O, Stanga Z; Ad Hoc ESPEN Working Group. 2003. Nutritional risk screening (NRS 2002): a new method based on an analysis of controlled clinical trials. Clin Nutr 22:321-36.

Kotseva K, Wood D, De Backer G, et al. 2009. EUROASPIRE III: a survey on the lifestyle, risk factors and use of cardioprotective drug therapies in coronary patients from 22 European countries. Eur J Cardiovasc Prev Rehabil 16:121-37.

Kyle UG, Kossovsky MP, Karsegard VL, Pichard C. 2006. Comparison of tools for nutritional assessment and screening at hospital admission: a population study. Clin Nutr 25:409-17.

Laviano A, Muscaritoli M, Cascino A, et al. 2005. Branched-chain amino acids: the best compromise to achieve anabolism? Curr Opin Clin Nutr Metab Care 8:408-14.

Mechanick JI. 2004. Practical aspects of nutritional support for wound-healing patients. Am J Surg 188:52-6.

McGillivray G, Skull SA, Davie G, et al. 2007. High prevalence of asymptomatic vitamin D and iron deficiency in East African immigrant children and adolescents living in a temperate climate. Arch Dis Child 92:1088-93.

Miyake K, Miyake N, Kondo S, Tabe Y, Ohsaka A, Miida T. Seasonal variation in liver function tests: a time-series analysis of outpatient data. Ann Clin Biochem 46:377-84.

Ogawa M, Tanaka F, Onoda T, et al. 2007. A community based epidemiological and clinical study of hospitalization of patients with congestive heart failure in Northern Iwate, Japan. Circ J 71:455-9.

Pirlich M, Schutz T, Norman K, et al. 2006. The German hospital malnutrition study. Clin Nutr 25:563-72.

Sanchez JA, Sanchez LL, Dudrick SJ. 2011. Nutritional considerations in adult cardiothoracic surgical patients. Surg Clin North Am 91:857-75, ix.

Shahar DR, Froom P, Harari G, Yerushalmi N, Lubin F, Kristal-Boneh E. 1999. Changes in dietary intake account for seasonal changes in cardiovascular disease risk factors. Eur J Clin Nutr 53:395-400.

Shinchuk LM, Holick MF. 2007. Vitamin D and rehabilitation: improving functional outcomes. Nutr Clin Pract 22:297-304.

Sorensen HT, Horvath-Puho E, Sogaard KK, et al. 2009. Arterial cardiovascular events, statins, low-dose aspirin and subsequent risk of venous thromboembolism: a population-based case-control study. J Thromb Haemost 7:521-8.

van Venrooij LM, de Vos R, Zijlstra E, Borgmeijer-Hoelen MM, van Leeuwen PA, de Mol BA. 2011. The impact of low preoperative fat-free body mass on infections and length of stay after cardiac surgery: a prospective cohort study. J Thorac Cardiovasc Surg 142:1263-9.

Vrazic H, Sikic J, Lucijanic T, et al. 2012. The prevalence of overweight and obesity among Croatian hospitalized coronary heart disease patients. Coll Antropol 36 (Suppl 1):211-6.

Wedick NM, Barrett-Connor E, Knoke JD, Wingard DL. 2002. The relationship between weight loss and all-cause mortality in older men and women with and without diabetes mellitus: the Rancho Bernardo study. J Am Geriatr Soc 50:1810-5.

Wirth R, Smoliner C, Sieber CC, Volkert D. 2011. Cognitive function is associated with body composition and nutritional risk of geriatric patients. J Nutr Health Aging 15:706-10.