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NUTRITIONAL AND PHYSICAL-FITNESS FACTORS COURSING WITH NON-COMMUNICABLE DISEASES FROM OVERWEIGHT TO A HIGHER RISK OF VASCULAR AND LIVER OUTCOMES IN A COMMUNITY-BASED ADULTS

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Abstract: The burst of Non-Communicable Chronic Diseases (NCDs) seen in the last half-century, by the increased overweight and showing Cardio-Vascular Diseases (CVD) as the leading mortality outcome, might have epigenetic basis upon the mismatch of our ancient genome with the modern environmental behavior. Presently, we studied food inadequacy and physical unfitness associated with the prevalence of some NCD-related abnormalities from steps of obesity to more severe outcomes. For so, we analyzed data from 1,171 subjects, free-attendants of the dynamic cohort study "Move for Health" (2005 to 2019). Adults over 35-yr old were clinically selected and assessed for demographic, socioeconomic, physical activity, fitness, dietary quality and food intake along with body composition and plasma biochemistry for diagnosing NCDs. The mostly female, over 60- yr old, low-middle class sample, referred diet-inadequacy (91.9%) with highly processed food. Physical inactivity rate was 18.3% and 50.9% low trunk-flexibility as their major unfitness. Overweight was 82.1%, obesity 39%, abdominal obesity 51.2% and low-muscle mass 10.3%. MetS prevailed 61.1%, NAFLD 59.6% and hepatic fibrosis 0.6%, T2D was 17.2%. The main abnormalities were for high WC (51.2%), hypertriglyceridemic – waist (37.8%), blood hypertension (28.7%) and low-HDL chol. (16.7%). The prevalence of higher risks of PAI and CHD were 32.1% and 31.4%, respectively. Inadequate diet led to lower increase than physical inactivity for the NAFLD, lower muscle mass, PAI higher –risk and CHD. Then, not only poor-dietary quality but also, and mainly, low-physical activity and low fitness acted as behavioral factors increasing selectively the NCDs. These suggest that an allostasis pro-active model of lifestyle modification, involving supervised- physical exercises and counseled-dietary adequacy would be clinically appropriate for taking care of those contemporary NCDs having evolutionary thriftiness as their common background.

Keywords: Non-communicable chronic diseases, food inadequacy, physical inactivity, sedentary behavior

INTRODUCTION

Based on existing trends, non-communicable disease (NCDs) are expected to account for 70% of deaths and 60% of the disease burden (WHO, 2008). In Brazil, NCDs accounts for 74% deaths and have cardiovascular disease (CVD) as the leading cause (31%) of all deaths (WHO, 2011). In general, CVD is the leading cause of death in the world, comprising almost 30% of all deaths. Global CVD deaths are projected to increase to roughly 35% of all deaths in 2030 (OHIRA; ISO, 2013).

As a major NCD, obesity is rising in epidemic proportions that herald dramatic negative influences on the health of the population in the decades to come. The OR of CVD-mortality associated with obesity jumps from 0.92-1.13 at BMI 25-29.9 kg/m^2 to 1.57-3.21 on BMI≥40kg/m^2 (JIANG *et al.*, 2013). In this century, the obesity crisis has been associated with an alarming increase in the prevalence of the Metabolic Syndrome (MetS) (MEIGS, 2002). Often, the accumulation of lipid in the liver often accompanies and parallels weight gain and obesity and is a major marker of MetS (DESPRES; LEMIEUX, 2006).

The metabolic syndrome is recognized as a pervasive condition related to cardiovascular atherosclerotic ischemic disease due to the presence of a clustering of three or more risk factors, including abdominal obesity, atherogenic dyslipidemia (hypertriglyceridemia, low HDL cholesterol), raised blood pressure and fasting plasma glucose (KHOO; OLIVEIRA; CHENG, 2013).

Lipid abnormalities found in MetS have been identified to support the development of atherosclerosis and other CVDs. MetS increases 3 to 5 the chances of T2D and doubles the chance of cardiovascular diseases (CVDs) (SINGH *et al.*, 2012). Weight gain and obesity are major risk factors for nonalcoholic fatty liver disease. Non-alcoholic fatty liver disease (NAFLD) is a chronic condition characterized by the accumulation of fat in the liver in the absence of other causes of steatosis, including excess consumption of alcohol or drugs (ANGULO, 2002).

NAFLD is more frequent among obese subjects (75%) compared with controls (16%) and among patients with type 2 diabetes mellitus (T2D) (34–74%), whereas it is an almost universal finding in obese patients with T2D. Up to 90% of patients with NAFLD have simple steatosis, which carries a relatively benign prognosis (TELI *et al.*, 1995), with no overall increase in mortality (DAM-LARSEN, 2004; EKSTEDT *et al.*, 2006; MATTEONI *et al.*, 1999). However, approximately 10–30% have the potentially progressive form of NAFLD, non-alcoholic steatohepatitis (NASH), which is associated with hepatocellular injury (MATTEONI *et al.*, 1999; WANLESS; LENTZ, 1990; WILLIAMS *et al.*, 2011).

Approximately 25–40% of patients with NASH will develop progressive liver fibrosis, ultimately resulting in cirrhosis in 20–30% (ADAMS *et al.*, 2005; EKSTEDT *et al.*, 2006; FASSIO *et al.*, 2004; MATTEONI *et al.*, 1999; WONG *et al.*, 2010). Hence, NAFLD is the most common cause of chronic liver disease, constituting a major risk factor for progression to liver failure, cirrhosis, and hepatocellular carcinoma (ANGULO, 2002; ANGULO; LINDOR, 2002; CALDWELL *et al.*, 1999). The development of NASH cirrhosis is associated with a poor long-term prognosis. The 10-year mortality rate is 20% for subjects with Child-Pugh A disease and 45% will decompensate within 10 years of diagnosis (SANYAL *et al.*, 2006).

NAFLD is also a risk factor for coronary heart disease leading to a higher risk (10X) of liver-related premature mortality. The leading cause of death in patients with NAFLD is cardiovascular mortality. In addition to having an increased liver-related mortality rate compared with a reference population (2.8% vs 0.2%), patients with NASH also have an increased risk of cardiovascular death (15.5% vs 7.5%) (DYSON; ANSTEE; MCPHERSON, 2014; EKSTEDT *et al.*, 2006). NAFLD predicts cardiovascular disease such as arterial hypertension, and also T2D. The role of liver failure leading CVD would be the combination of atherogenic dyslipidemia and hyperglycemia (TARGHER *et al.*, 2005; VILLANOVA *et al.*, 2005). NAFLD has a pro-atherogenic serum lipid profile consisted by a low HDL cholesterol and high triglyceride levels, small, dense LDL particles, and high apolipoprotein B100 levels (ADIELS *et al.*, 2006; CALI *et al.*, 2007; KIM *et al.*, 2004; TASKINEN, 2003; TOLEDO; SNIDERMAN; KELLEY, 2006).

Since 1980, obesity rates have risen more than 3-fold in some areas of North America, the United Kingdom, Eastern Europe, the Middle East, the Pacific Islands, Australasia, and China. Very worrisome are the concurrent and parallel increases in the prevalence of pathologic conditions associated with obesity, which include T2D, CVD, hypertension, hypercholesterolemia, hypertriglyceridemia (HTG), NAFLD, arthritis, asthma, and certain forms of cancer (SHOELSON; HERRERO; NAAZ, 2007). Evolutionary Medicine rests on the assumption that functional biological characteristics are the result of evolutionary adaptive processes. Organisms are bundles of compromises shaped by natural selection and, humans and other primates have evolved particular morphological and biological traits. The evolution of these traits is viewed as product of interactions between intrinsic constraints and trade-offs—features inherited or acquired during development—and extrinsic factors in the environment that affect mortality risk and resource availability (BURINI, Roberto Carlos; LEONARD, 2018).

Major constraints were famine and infection. Hence, life is the interplay between structure and energy and, the major functions involved in lifespan are maintenance, growth, reproduction, and defense, in which energy can be invested. For those, insulin resistance, sodium preservation and inflammation can be seen as thriftiness in situations such as famine, water privation and infection. For then, emerged the thrifty genotype that implies some degree of prosperity deriving from earlier frugality and a careful management of resources. Therefore, it is possible to analyze a great number of diseases in terms of adaptive vulnerabilities connected to our phylogenetic inheritance, such as human bodily inadequacies in relation to the modern environment. In fact, the mismatch of our ancestral thrifty genotype with the contemporary way of life would result in diseases such as obesity, T2D, essential hypertension, dyslipidemia and MetS. Thus, epigenetic modification of gene expression is one mechanism by which genetic susceptibility and environmental insults can lead to mostly of the contemporary NCDs (BURINI, Roberto Carlos; *et al.*, 2017; BURINI, Roberto Carlos *et al.*, 2013, 2016; PORTERO MCLELLAN *et al.*, 2013).

The modern human bodily inadequacies in relation to the modern environment can be associated with dietary inadequacy and physical inactivity. Physical activity may modulate NCDs by controlling cardiorespiratory fitness (mitochondria biogenesis, beta oxidation and vasodilatation) and body fatness through the energy expenditure (BURINI, Roberto Carlos, 2017). Additionally, nutritional behavior modulates may by eating: high energy-dense food, highly refined carbohydrate (CHO) and fat diet, low-micronutrient diet (BURINI, Roberto Carlos *et al.*, 2017).

Physical inactivity, described as a condition of not reaching the public health guidelines for the recommended levels of moderate to vigorous physical activity (HALLAL *et al.*, 2012), is recognized as the biggest public health problem of the 21st century (BLAIR, 2009). This study aimed to raise the contribution of nutritional inadequacy and physical unfitness FACTORS in the course of overweight-associated CVDs in free-livings subjects.

METHODS

STUDY DESIGN AND SUBJECTS

A cross-sectional, retrospective and descriptive study was carried out in participants (2004 to 2019) of lifestyle modification program (LSMP) "Move For Health", a dynamic cohort study. Participants were adults (over 35 years of age), of both genders, who voluntarily sought the LSMP by spontaneous demand or by medical recommendation with the aim of preventing or changing their behavior. The LSMP consisted of combined exercise and nutritional counseling (BURINI, Roberto Carlos, 2022). The present study included data from 1171 adults that upon registration signed up an informed consent form in accordance with Resolution 466/2012 of the Local Research Ethics Committee (CEP) of the Botucatu Medical School, for this study approval (nº 2.205.517/ CAAE:67008717.9.0000.5411).

ASSESSMENTS

Clinical anamnesis was performed to obtain data regarding personal and family history for NCDs (obesity, T2D, hypertension, osteoporosis and CVDs), as well as the use of medications and possible osteo-articular limitations that limited the regular practice of physical exercise. Blood pressure was determined by the auscultatory method, using an aneroid sphygmomanometer (duly calibrated) and a stethoscope following the IV Brazilian Guidelines on Hypertension (IV BRAZILIAN GUIDELINES IN ARTERIAL HYPERTENSION WORK GROUPS, 2004).

The level of physical activity and socioeconomic and demographic data (gender, age, civil status, healthy status, family income, and education) were obtained by the International Physical Activity Questionnaire (IPAQ version 8 - long form, The recommended level of physical activity was considered when greater than and equal to 150 minutes per week (CRAIG *et al.*, 2003) but diverse physical activity measures in use prevent international comparisons. The International Physical Activity Questionnaire (IPAQ.

Body weight and height were used to calculate the Body Mass Index (BMI) which was classified as obesity following the World Health Organization (WHO) criteria ((WHO), 2000). Waist circumference (WC) was measured with the aid of an inelastic tape measuring with 0.1 cm precision at the midpoint between the last rib and the iliac crest, enabling the estimation of abdominal adiposity used to classify altered WC in the diagnosis of MetS and Abdominal Obesity (GRUNDY *et al.*, 2005). Body fatness was determined by bioelectrical impedance (BIA) (Biodynamics®, model 450, USA) and muscle mass was obtaining from the resistance value (JANSSEN *et al.*, 2000):

Muscle Mass (MM) (kg) = [(height^2/ resistance (ohms)) x 0.401) + (0 x 3.825) + (age (years) x – 0.071)] + 5.102.

The Muscle Mass Index (MMI) was calculated using the equation (BAUMGARTNER *et al.*, 1998)leading to 'sarcopenia,' or low relative muscle mass, in elderly people. Sarcopenia is believed to be associated with metabolic, physiologic, and functional impairments and disability. Methods of estimating the prevalence of sarcopenia and its associated risks in elderly populations are lacking. Data from a population-based survey of 883 elderly Hispanic and non-Hispanic white men and women living in New Mexico (the New Mexico Elder Health Survey, 1993-1995:

MMI ((kg/m^2) = MM (kg)/height (m)^2

The low-MMI was considered the lower decile of the sample (P10).

After 3 recalls, the average 24h-food intake was processed by the Nutwin nutritional analysis program (Nutwin®, Support Program for Nutrition, see 1.5, UNIFESP, 2002). Data on food intake were converted into portions according to energy content and food group and evaluated for the Healthy Eating Index (HEI). The HEI was considered inadequate when below 100 points (HEI<100 points) (MOTA *et al.*, 2008; PHILIPPI *et al.*, 1999)de ambos os sexos (54, desvio-padrão=10 anos.

Blood samples were collected by vacuum venipuncture from participants after an overnight fast (8 hours). The blood tubes underwent 10 minutes of centrifugation at 4000 rpm with subsequent separation of serum and plasma aliquots for measurement of biochemical indicators, as well as the storage of 2 mL of serum and 2 mL of plasma in a freezer at -80° C for subsequent dosage. Serum concentrations of triacylglycerol (TG), total cholesterol (TC), high density lipoprotein (HDL-c), fasting plasma glucose, gamma-glutamyl transpeptidase (γ-GT), aspartate aminotransferase (AST) and alanine aminotransferase (ALT) were performed by the dry chemistry method (Vitros 5600®, Johnson & Johnson®, Ortho Clinical

Diagnostic, Raritran, NJ, USA).

The presence of T2D was considered when glucose concentrations were greater than and equal to 126 mg/dL ((ADA), 2018). The presence of MetS occurred in the presence of 3 or more altered components (WC, TG, HDL-chol., glucose and blood pressure) (GRUNDY *et al.*, 2005).

The Fat Liver Index (FLI) (BEDOGNI *et al.*, 2006) was used to verify the risk and presence of NAFLD. This index used the following parameters for calculation: BMI, WC, γ-GT and TG. The FLI<60 represented the absence or tolerable content of liver fat, while FLI≥60 represented the liver fat content that indicates the presence of NAFLD (BEDOGNI *et al.*, 2006).

The Hepatic Fibrosis Index (HFI) was used as the "NAFLD Fibrosis Score", which indicates the absence or presence of fibrosis in individuals with NAFLD (ANGULO *et al.*, 2007). The variables used for the calculation are: age, BMI, presence of T2D, AST/ALT ratio, total platelet count (x109/L) and albumin. HFI values below -1.455 indicate the absence of hepatic fibrosis, values between -1.455 and 0.676 indicate tolerable fibrosis and values above 0.676 indicate the presence of hepatic fibrosis (ANGULO *et al.*, 2007).

The Plasma Atherogenic Index (PAI) used to predict the risk of atherosclerosis and coronary artery disease (CAD), was calculated by the algorithm: log (TG/HDL-c). Values below 0.11 represent low risk, 0.11 to 0.21: medium risk, >0.21: high risk (HERMANS; AHN; ROUSSEAU, 2012).

The Framingham Risk Score (FRS) measured the risk of dying from CVDs, experiencing angina or having a myocardial infarction, in the next 10 years (D'AGOSTINO *et al.*, 2008; WILSON *et al.*, 1998). The FRS calculation uses the variables: age (in years), gender (female/male), smoking (yes/no), TC and HDL-c concentrations, systolic blood pressure and T2D (yes/no). FRS below 10% represents low risk, 10%-20% medium risk and above 20% high risk for CAD (D'AGOSTINO *et al.*, 2008; WILSON *et al.*, 1998).

The data obtained were computed in Microsoft Excel software and duly classified as altered/normal, presence/absence, adequacy/inadequacy, low/medium/high risk or recommended/not recommended, followed by further statistical analysis. Shapiro-Wilk test was performed to verify the distribution (parametric/non-parametric) of the analyzed data. Categorical data were represented in number (quantity) and percentage, while continuous data expressed as median (minimum-maximum). Analyzes were performed in STATISTICA software ver.10.0. The significance level considered was 5% ($p<0.05$).

RESULTS

CHARACTERISTICS OF THE WHOLE SAMPLE

The attended sample was 35 to 72 years old (median=50.3), 51.2% over 60 years and 79% women. Most were married, had completed Elementary School and were living with a family income below 5 minimum wages. Although 79.2% reporting regular-good health, 91.9% of the sample showed inadequate diet (HEI<100 points) and 18.3% with physical activity below the recommended 150min./wk level (673.5(0.0-4350.7) min./wk) (Table 1).

Low fitness was 25.7% for VO2max, (28.1(16.1-40.7) mL/kg/min.), 28.9% hand grip strength (27.5(10.0-60.0) kgf) and 50.9% trunk flexibility (20.3(0.0-46.0) cm). Food intake inadequacy was detected in 53.9% for high CHO/Fiber (≥19) and 40.3% with sodium/potassium ratio higher than 1.0 (Table 1).

NON-COMMUNICABLE DISEASES

Among the NCDs, overweight was 82.1%, obesity 39%, abdominal obesity 51.2% and low-muscle mass(sarcopenia) 10.3%. MetS prevailed 61.1%, NAFLD 59.6% and hepatic fibrosis 0.6%. T2D was 17.2% (Figure 1). The main abnormalities varied from 51.2% for high waist circumference, 37.8% hypertriglyceridemic –waist, 28.7% blood hypertension and 16.7% low-HDL chol. The prevalence of high risk by PAI and Risk for CAD by FRS was 32.1% and 31.4%, respectively (Figure 1).

Inadequate diet (HEI <100 points) affected maximum HFI (6.5%), lower MMI (6%), higher –risk PAI (5.9%) PAI high risk (5.3%) and CAD high risk (5.4%) (Table 2 and Figure 3). In the presence of low-physical activity (IPAQ<150 min./wk) there was an increased prevalence of low MMI (19%), CAD high risk (14.1%), PAI high risk (13.7%), T2D (,13.3%) LF (11.8%), NAFLD (8.8%) and MetS (6%) (Table 2 and Figure 3).

The fitness of lower VO2max, and lower hand-grip strength followed the same pattern described for the low-physical activity (Table 2 and Figure 2).

The self-referred low -physical activity (18.3%) was associated with lower increase of prevalences of major pathologies compared to those seen in objective-measured physical-fitness (Figure 2). The ranking of the four major increased-pathologies led by the three-assessed unfitness, was similar, beginning with low-muscle mass (46-49% higher) and ending with higher-hepatic fibrosis index (21.4% to 35.7% higher). So much in low-physical activity, as well as in all three fitness the resulted impact on obesity was very much lower than those seen on low-muscle mass (Figure 2).

The self-referred low –dietary quality (91.9%) affected the obesity, lesser than it did on the other pathologies and, it affected the others similarly (Figure 3). Therefore, the imbalanced CHO/Fiber and Sodium/Potassium discriminated better the pathologies than the HEI (Figure 3). Overall, low-muscle mass suffered lesser increasing by inadequate CHO/Fiber intake and T2D increased lesser than other pathologies under the inadequate Na/K intake. T2D increased 46.1% under inadequate CHO/Fiber intake and Blood Hypertension increase 52.1% under the inadequate Na/K intake (Figure 3) .

Though, not only low-physical activity but also low fitness acted as behavior factor modulating low- MMI (sarcopenia), T2D, risks of atherogenesis and CAD, NAFLD and Liver Fibrosis.

DISCUSSION

The studied subjects were from a lower middle-class community looking for healthy lifestyle. As earlier demonstrated, they were mostly women, married, retired, housekeepers (BURINI, Roberto Carlos, 2022). Dietary inadequacy averaged 91.9%, along with 53.9% of high consumption of single sugar (CHO/Fiber ratio≥19) and 40.3% of high sodium intake (sodium/potassium ratio≥1.0), strongly suggesting a pattern of fast-food with ultra-processed foods (BAILEY *et al.*, 2015; BERNARDINO *et al.*, 2016). Actually, the prevalence o T2D practically doubled in those patients with CHO/Fiber≥19. Similarly happened for Blood Hypertension in presence of Na/K≥1.0.

The found levels of obesity, MetS, NAFLD, blood hypertension, dyslipidemia and other NCD-related abnormalities were expected for mature-old subjects that sought public-health service for general purpose. Even though with these high screen of pathologies, their self-perception of health status showed 79.2% referring regular-good status. Actually, both, self-perception of health status and 24hlfood intake had both, in common, by

Parameters	n(%) or Median(minimum-maximum) or Mean ± SD
Age (years)	54.0(35.0-85.0)
< 60 years old	571(48.8)
> 60 years old	600(51.2)
Genre	
Woman	925(79.0)
Man	246(21.0)
Civil status	
Married	803(68.6)
Unmarried	368(31.4)
Education	
Incomplete Primary School (%)	277(23.6)
Complete Primary School (%)	500(42.7)
Complete High School (%)	255(21.8)
Complete College (%)	139(11.9)
Income (minimum wage)	
< 5 mw	980(83.7)
> 5 mw	191(16.3)
Healthy status	
Bad	244(20.9)
Regular	662(56.6)
Good	265(22.6)
HEI	
Inadequate	972(91.9)
Adequate	86(8.13)
HEI (points)	82.4 ± 23.1
CHO/Fiber inadequate	631(53.9)
CHO/Fiber ratio	19.3(1.4-68.5)
Sodium/Potassium inadequate	472(40.3)
Sodium/Potassium ratio	1.03(0.08-6.3)
Physical fitness	
Physical activity level (<150min/wk)	214(18.3)
Physical activity level	673.5(0.0-4350.7)
VO2max (low<p25)	301(25.7)
VO2max (mL/kg/min)	28.1(16.1-40.7)
Handgrip strength (bad)	338(28.9)
Handgrip (kgF)	27.5(10.0-60.0)
Flexibility (bad)	596(50.9)
Flexibility (cm)	20.3(0.0-46.0)

Age expressed as median (minimum-maximum) or Mean ± SD. SD: standard deviation. The other variables expressed in quantity (percentage). PAL: Physical Activity Level. VO2max: maximum oxygen consumption. HEI: Healthy Eating Index. CHO: carbohydrate. n: number of individuals; mw: minimum wage, HEI: healthy eating index.

Table 1. Socioeconomic, food quality and physical fitness characterization of the subjects (n = 1171).

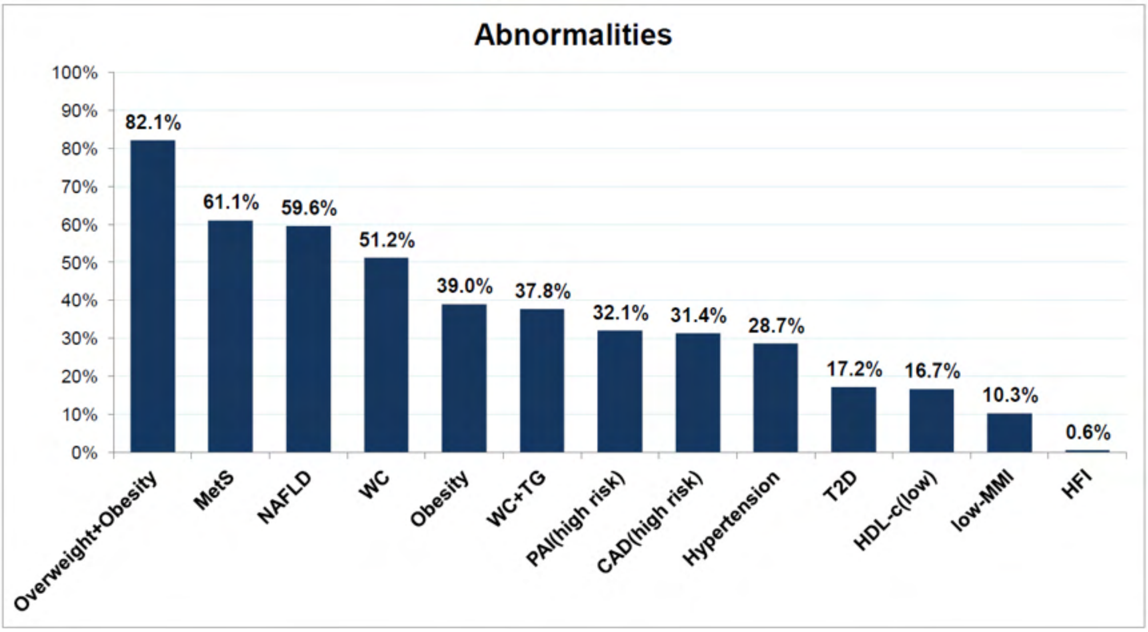

Figure 1. Prevalence of NCDs and major abnormalities in a community sample of free-living adults.

	Prevalence												
Parameters	General	Overweight+ Obesity	MetS	NAFLD	WC	Obesity	WC+TG	PAI (high risk)	CAD (high risk)	Hypertension	T2D	HDL-c (low)	low-MMI	HFI
PAL (low)	18,3%	21,4%	24,3%	27,1%	22,2%	19,8%	22,9%	32,0%	32,4%	16,5%	31,6%	14,2%	37,3%	30,1%
VO2max (low)	25,7%	29,1%	36,2%	42,7%	29,7%	26,3%	40,4%	65,6%	68,3%	37,3%	49,1%	43,1%	71,8%	61,4%
Handgrip (bad)	28,9%	25,4%	37,5%	45,8%	31,3%	29,5%	34,8%	59,9%	62,4%	26,1%	42,7%	31,5%	75,2%	50,3%
Flexibility (bad)	50,9%	57,5%	66,8%	70,1%	61,5%	60,7%	64,9%	88,5%	90,2%	32,4%	72,5%	38,6%	100,0%	85,8%
HEI (inadequate)	91,7%	90,0%	92,4%	93,6%	90,1%	88,2%	91,9%	97,0%	97,1%	84,5%	95,6%	80,6%	97,7%	98,2%
CHO/Fiber (inadequate)	53,9%	52,4%	71,5%	76,7%	59,8%	62,3%	68,4%	98,4%	98,6%	45,6%	100,0%	47,9%	82,5%	100,0%
Na/K (inadequate)	40,3%	36,4%	69,7%	75,5%	40,1%	37,9%	50,8%	97,6%	100,0%	92,4%	83,6%	31,3%	89,5%	95,8%

MetS: Metabolic Syndrome. NAFLD: Non-Alcoholic Fatty Liver Disease. WC: altered waist circumference. WC+TG: altered waist circumference with hypertriglyceridemia. PAI: Plasma Atherogenic Index. CAD: Coronary Artery Disease. T2D: Type 2 Diabetes Mellitus. MMI: Muscle Mass Index. PAL: Physical Activity Level. VO2max: maximum oxygen consumption. HEI: Healthy Eating Index. CHO: carbohydrate. Na: sodium. K: potassium.

Table 2. Prevalence of inadequete diet quality and poor physical firness in Geral population and separated by abnormalities

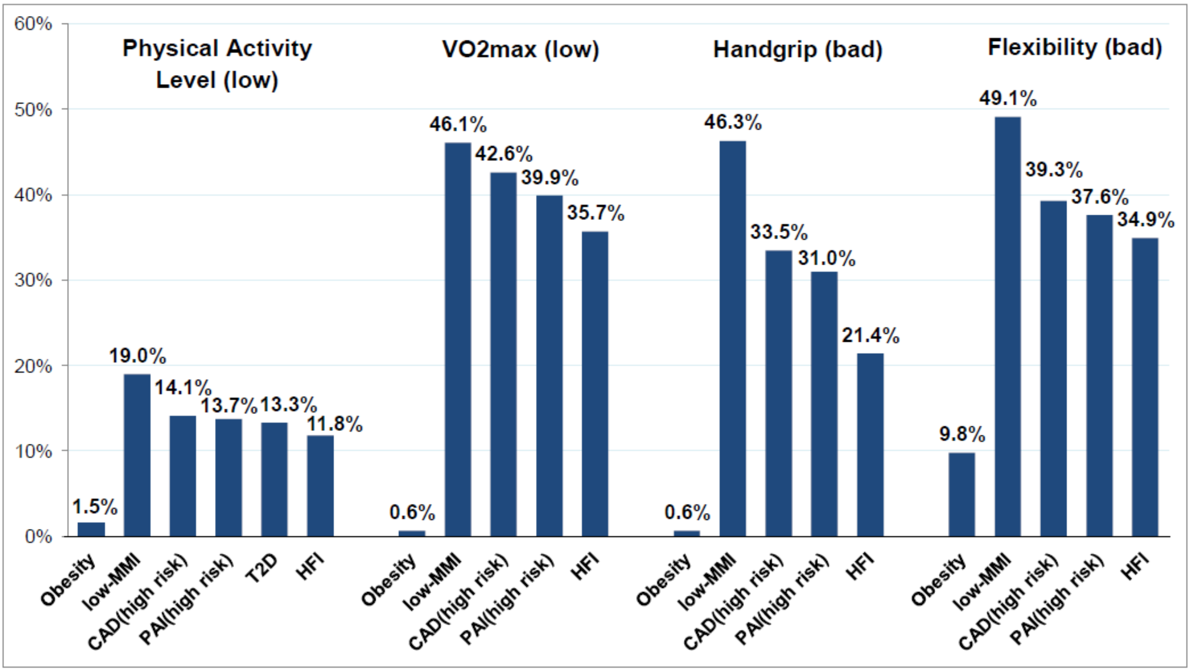

Figure 2. Increased prevalence(%) of major metabolic abnormalities led by inadequate physical activity and lower fitness in a community sample of free-living adults.

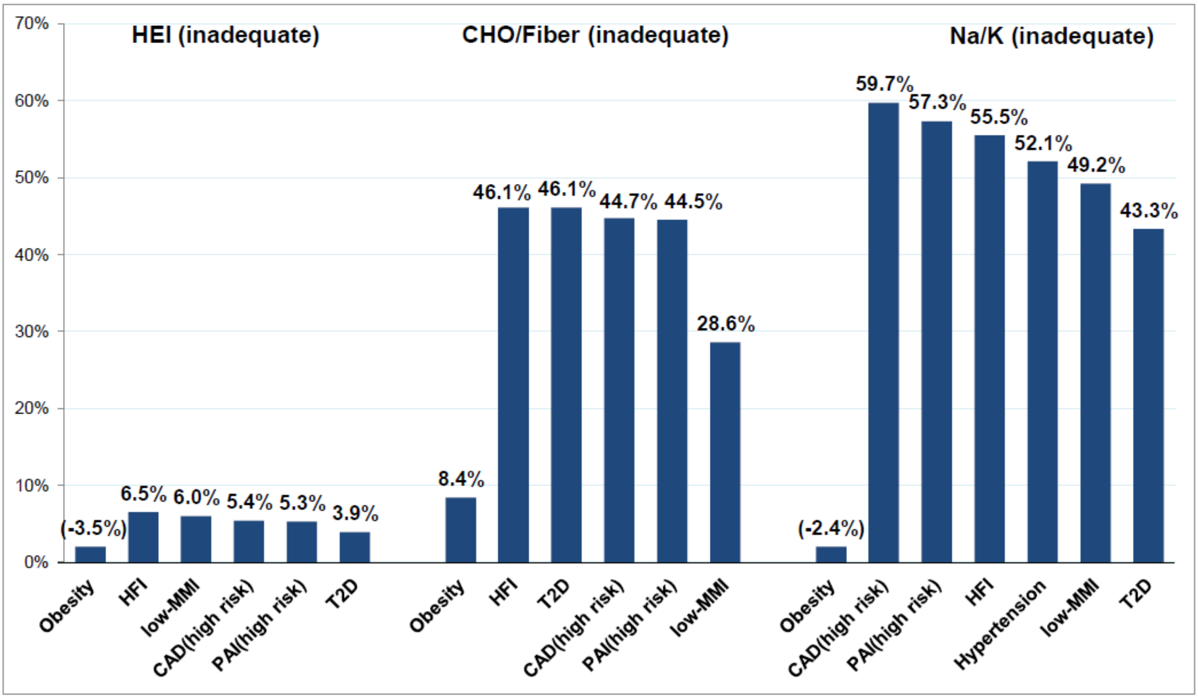

Figure 3. Increased prevalence(%) of major metabolic abnormalilties led by inadequate diet-quality and disproportionate intake of nutrients in a community sample of free-living adults.

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being qualitative data, obtained through questionnaires. Even tough conducted by professionals, these questionnaires, usually introduces gaps in the data. Similarly, the physical activity counting follows the same criticism. Presently only 18.3% referred themselves below 150min/wk (low-physical activity). Counteracting there were objectively measured a 25.7% of low VO2max., 28.9% of measured low handgrip and 50.9% of measured low trunk-flexibility. However, our data of physical inactivity agrees with the worldwide data of one-fourth of adults physically inactive (SALLIS *et al.*, 2016) and disagrees with the data of 46% Brazilian adults that would be in the inactivity condition (MIELKE *et al.*, 2015; WORLD HEALTH ORGANIZATION (WHO, 2010).

Among the NCDs, overweight was 82.1%, obesity 39%, abdominal obesity 51.2% and low-MMI 10.3%. Surprisingly, hyperadiposity (overweight, general and abdominal obesity) was much less affected by either dietary inadequacy or physical inactivity/unfitness than it was the low-muscle mass (sarcopenia). HEI score was so badly ranked that was unable to discriminate any metabolic abnormality. Even though, T2D was discriminate by higher CHO/Fiber ratio (simple sugar) while high Sodium/Potassium ratio (manufactured food) discriminate hypertension as well as T2D and low-MMI.

As pointed out earlier, lower aerobic fitness was risk factor for obesity, T2D, blood hypertension and metabolic syndrome, whereas lower IPAQ and poor flexibility were risk factors for obesity (BURINI, Roberto Carlos, 2022).

In 2010, 48% of the Brazilian adult-females and 50% of men were considered overweight (INSTITUTO BRASILEIRO DE GEOGRAFIA E ESTATÍSTICA - IBGE, 2010). Our data showed 82.1% of the sample as overweight. It is known that shortly after the end of World War II, an unprecedented environmental change took place in the western part of the globe. For the first time in human experience, the eating habits entire nations were altered by the marketing of processed food having in common a high carbohydrate and fat content, very low cost, and easy availability in supermarkets and fast-food restaurants. The aggressive promotion of these foods, coupled with a reduction in caloric expenditure resulting from new immobilizing technologies, changed the caloric balance of at least two generations of people. After a half-century of this nutritional revolution, obesity rates have risen more than 3-fold and less than 40% of the American population had a normal BMI (UNGER, 2003).

The burden of NCDs in Brazil has demonstrated the onerous expansion of pharmaceutical care and the free distribution of most NCD's medications, as an ineffective action in controlling these diseases (BURINI, Roberto Carlos, 2021a). Underlying why drug therapy has been largely unsuccessful in halting and reversing the NCDs epidemic would be the ineffectiveness of the treatment approach by homeostasis model. Based on this model physicians reason that when a parameter deviates from its setpoint value, some internal mechanism must be broken. Consequently, they design therapies to restore the "inappropriate" value to "normal". But the fundamental goal for life is not constancy, instead the coordinated variation to optimize performance at the least cost. This is the core idea of allostasis (BURINI, Roberto Carlos, 2021b). The allostasis model defines health as optimal predictive fluctuation. A system becomes unhealthy when, high demand predominates for long times, The allostasis model of physiological regulation, attributes NCDs diseases to sustained neural signals that arise from unsatisfactory social interactions (BURINI, Roberto Carlos, 2021b).

Among NCDs and metabolic abnormalities, dietary inadequacy affected majorly the low-MMI, liver fibrosis and the CVDs (atherogenesis high-risk and CAD). For these same abnormalities, the increasing seen by the presence of inadequate diet (5.9% to 6.5%) was less than half than those seen by the presence of physical inactivity and low fitness (11.8% to 19%). Thus, inadequate diet, low-physical activity and low fitness acted as behavior factor disturbing body composition and liver failure leading to T2D and CVDs.

Differently from treating low level targets by drugs (homeostatic model) and generating iatrogenesis, the allostasis model has a more rational goal of intervention with LSMP of environmental factors. The allostasis model attributes the pathogenesis of obesity, MetS and its components to prolonged adaptation to hypervigilance and hyposatisfaction to social interactions. Consequently, the allostasis model would redirect therapy, away from manipulating low-level mechanisms, toward improving higher levels in order to restore predictive fluctuation. Under this model the hallmark of health is the therapeutics of contemporary chronic diseases through changing lifestyle which seems more clinically effective than drugs (BURINI, Roberto Carlos, 2021b). This is the basis of the Behavioral Medicine. Among its principles, dietary adequacy and physical activity as pillars of treatment. They could be a natural remedy for recovering part of the imbalance caused by modern life-styles, costless and without the side effects of many pharmacological treatments (BURINI, Roberto Carlos, 2017, 2022; BURINI, Roberto Carlos *et al.*, 2020). Thus an allostasis pro-active model of LSMP, involving supervised-physical exercises and dietary counseling seems more clinically effective than drugs for these contemporary chronic diseases having evolutionary thriftiness involved in their origin.

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