



NON COMMUNICABLE DISEASES

Relationship between dietary energy intake, nutritional status and cardiovascular risk in adults from the communes of Quellón and Chonchi, Chiloé, Chile

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Keywords

Dietary energy intake • Malnutrition by excess • Nutritional adequacy of the diet • Chronic diseases • Cardiovascular risk

Summary

Introduction. Behavioural and metabolic risk factors are responsible for the greatest burden of disease; an unhealthy diet, along with abdominal obesity, are risk factors related to Non-communicable diseases (NCDs).

Methods. Data concerning food patterns were determined by the application of an interview-type instrument, used to assess the daily and weekly frequency of consumption; cardiovascular risk was assessed using waist circumference, and nutritional status via Body Mass Index. Student's *t* test was applied to evaluate the differences between variables and the Pearson's chi-square test for the association of variables.

Results. Dietary energy intake (kcal/capita/day) was 3000 kcal, with an average distribution of 12.2% (proteins), 46.9% (carbo-

hydrates), and 40.9% (total fats). The 78% of the sample suffered from malnutrition by excess. About 37.5% had Non-Communicable Diseases, with high blood pressure being the most frequent disease among both genders, with the highest prevalence among women, along with diabetes mellitus and dyslipidaemia. Depending on the nutritional status, the presence of obesity is associated with high cardiovascular risk ($p = 0.000$), greater energy availability ($p = 0.012$), and an increased occurrence of non-communicable diseases ($p = 0.004$).

Conclusions. Malnutrition by excess figures support the global alert for obesity and overweight, which are considered to be a pandemic; in addition, Chiloé is not immune to the increasing trend of processed and ultra-processed food consumption.

Introduction

Behavioural and metabolic risk factors are responsible for the greatest burden of disease. It is observed that an unhealthy diet, along with abdominal obesity, are some of the risk factors related to Non-communicable diseases (NCDs) [1], therefore, having knowledge of the diet and eating patterns of the population is a priority, in order to establish actions to improve them.

The burden that NCDs represents for health and economic development is one of the greatest challenges of the 21st century, causing 71% of all deaths globally, besides being the primary cause of disability [2]. Each year, 15 million people aged between 30-69 years die from a NCD, and more than 85% of these deaths occur in low and middle-income countries [3]. Because of the high costs of reducing deaths and the impact of NCDs on the economies of the countries, NCDs are targeted in the United Nations Sustainable Development Goals (SDG) set out for 2030 [4].

In Chile, 74.2% of the population aged 18 years and older suffer from malnutrition by excess, showing an increase sustained over time, as shown by the latest National Health Surveys (NHS 2009-2010, NHS 2016-2017) and the Organisation for Economic Co-operation and Development (OECD 2019) [5, 6]. With respect to NCDs, 26.9% have High Blood Pressure (HBP), and 38.5% have Hypercholesterolemia, combined with unhealthy eating patterns, alcohol consumption, tobacco

use and a sedentary lifestyle, all this contributing to Cardiovascular Diseases (CVDs), which represent the leading cause of death in Chile [5]. On the other hand, there is not enough background information about the diet quality of the population and its evolution, and this information is even more limited in extreme zones of the country, such as the Chiloé Island. The first National Food Consumption Survey (NFCS, 2010) showed a low consumption of health protective foods, and a gap with respect to the consumption recommended in the Dietary Guidelines for the Chilean Population. Furthermore, the same survey indicated that 95% of the population required major changes in their diet [7], showing that in Chile, as is happening in other countries, accelerated changes have taken place during the last decades, impacting the habits, dietary practices and consumption patterns, affecting the health of the population [8]. In these context, given the importance of healthy diet and nutrition as protective factors to prevent NCDs, it is of great interest to know the dietary energy intake, nutritional adequacy of the diet, and nutritional status, and how they are related to cardiovascular risk (CVR) in a sample of adult patients of the Family Healthcare Centres (CESFAM, as per its acronym in Spanish) in isolated localities of Chile, as in the case of the communes of Quellón and Chonchi, in the Chiloé Island.

In the light of the above, the objective of this study is to know the energy intake and nutritional adequacy of

the diet, and to establish an association with nutritional status, cardiovascular risk and non-communicable diseases, in a sample of users of the Family Healthcare Centres (CESFAM) of Quellón and Chonchi, which are part of the primary healthcare network of the Chiloé Island.

Methods

A comparative, correlational-associative, cross-sectional study, with a non-experimental design, and a quantitative and qualitative approach was conducted. Dependent variables: nutritional status and cardiovascular risk; independent variable: nutritional adequacy of the diet. A convenience sample consisting of 200 adults (women $n = 153$, and men $n = 47$) aged between 18 and 89 years, who are users of the Family Healthcare Centres (CESFAM) of the communes of Quellón and Chonchi, of the Chiloé Island, Chile, was recruited for the study. The subjects voluntarily agreed to participate and signed the informed consent. Inclusion criteria were: to be a user of the CESFAM (subjects must be registered patients), voluntarily agree to answer the questionnaire the day it was applied, and to sign the informed consent. Exclusion criteria were: to be under 18 years old, and to not fully complete the questionnaire.

The study was developed following the Declaration of Helsinki regarding work involving human beings, and approved by the Bioethics Committee of the Academic Vice-Presidency of the Universidad de Playa Ancha, Chile. The field work was carried out in November 2017 by students of the last year of the Nutrition and Dietetics degree program of the Universidad de Playa Ancha, who were previously trained on the standardization of measurement protocols and application of the instruments. A questionnaire was developed and validated by expert judgment before its application. The judges who evaluated the questions were five experts with experience in the field of foods and nutrition, and they did not take part in the wording of the questions of the instrument. The questionnaire was applied as an interview and collected general background information such as age, gender, place of residence, occupation, income level, level of education, family size, family type, main NCDs (high blood pressure, diabetes mellitus, dyslipidaemia, and others), and anthropometric data such as weight, height and waist circumference. Body weight (kg) was measured with participants wearing the least amount of clothes possible, using a digital Omron scale with a maximum capacity of 220 kg and an accuracy of 50 g. Height (m) was measured using a SECA stadiometer, with a measuring range of 20–205 cm. A SECA measurement tape was used to measure waist circumference, at the midpoint between the last rib and the iliac crest. The body mass index (BMI) variable was calculated using the measurements of weight and height or Quetelet index defined as $(\text{weight}[\text{kg}]/\text{height}[\text{m}]^2)$; nutritional status was categorized according to the criteria established by the World Health Organization (WHO) as: normal

weight (18.5 to 24.9 kg/m²), overweight (25 to 29.9 kg/m²) and obese (≥ 30 kg/m²) [9]. CVR was evaluated by the measurement of abdominal fat, obtained by measuring waist circumference, and it was assessed according to the WHO standards. It was classified in: Low CVR: < 80 cm (women) and < 94 cm (men); Moderate CVR: ≥ 80 cm (women) and ≥ 94 cm (men); High CVR: ≥ 88 cm (women) and ≥ 102 cm (men) [10]. Dietary history was obtained by the application of a 24-hour recall questionnaire (R 24h) and a questionnaire of weekly frequency of consumption, applied as an interview. The food products consumed were recorded in household measures, and then standardized in g/ml, as appropriate, in order to subsequently make an estimation of energy intake, macronutrients, fibre and sodium.

Energy requirement was assessed by using the Resting Energy Expenditure (REE) formula provided by the WHO, and a correction factor of 1.3 was added (sedentary activity level). The distribution of nutritional adequacy was determined according to the classification of the Institute of Medicine (IOM) [11] in: proteins 15%, lipids 30%, carbohydrates 55%, fibre = 30 g/day, and sodium < 2000 mg/day (salt added to homemade meals was not included in this recommended intake). The calculation of nutritional adequacy (the ratio between estimated intake and recommended intake) was expressed as a percentage; an adequacy ranging from 90% to 110% was considered good. The following categories were established to distribute dietary energy intake of the sample (kcal/capita/day): < 2200 kcal; 2201–3000 kcal; and > 3000 kcal [12].

STATISTICAL ANALYSIS

Microsoft Excel 2013 (v15.0) was used to tabulate data. Absolute and relative frequencies were calculated for the categorical variables; arithmetic mean and standard deviation were used for the description and analysis of quantitative variables. The confidence interval was set at 95%, and the Student's *t* test was used to evaluate differences between the variables (Tab. I). Pearson's chi square test was used for the linear association of the variables, with a significance level of 95%. Statistical processing was performed with the Statistical Package for Social Science (SPSS) software version 22.0.

Results

The sample consisted of 200 adults enrolled in the public health system, who were patients at the Quellón and Chonchi Family Healthcare Centres; 76.5% of the subjects were women and 23.5% men.

Mean age was 42.6 ± 16.1 years; 99% of the participants have lived in the Chiloé Island during the last ten years, with the greatest proportion of them (61%) residing in Quellón. With regards to education, 47% only completed primary education (which starts at 6 years old and consists of a cycle of 8 years of training), and 2% had no schooling at all. The 59% of the sample were engaged in household work, and only 36% reported having a paid

Tab. I. Characteristics of the sample.

	N	%
Place of residence (10 years)		
Chonchi	76	38
Quellón	122	61
Other places	2	1
Gender		
Men	48	24
Women	152	76
Age		
18-39 years	89	44.5
40-64 years	85	42.5
≥ 65 years	26	11
Level of education		
Primary education	94	47
Secondary education	79	39.5
Technical education	15	7.5
Higher education	8	4.0
Unschooling	4	2.0
Family		
Nuclear	139	69.5
Single parent	27	13.5
Extended	10	5.0
Blended	24	12.0
Number of members		
< 3	97	48.5
4 to 6	93	46.5
> 6	10	5.0
Income level		
< 270,000 (< 465 USD)	59	29.5
270,000-500,000 (465-862 USD)	67	33.5
> 500,000 (> 862 USD)	18	9.0
Did not answer	32	16.0
Did not know	24	12.0
Occupation		
Unemployed	5	2.5
Housewife	90	59.0
Paid employment	99	35.5
Student	3	1.5
Retired	3	1.5

employment. About 30% received a monthly salary of less than \$ 270,000 (465.42 USD), and only 9% reported having an income greater than \$ 500,000 (861.89 USD) (Tab. II).

NUTRITIONAL STATUS

The classification, according to the BMI, indicated that 78.5% of the sample presented malnutrition by excess, with women having higher rates, reaching 81%. More than 50% have High CVR; among women the value is three times greater than among men. Moreover, 37.5% of the total sample suffer from NCDs, with HBP being the most frequent disease among both genders. The highest prevalence of HBP, diabetes mellitus, and dyslipidaemia occurs in women (Tab. I). With respect to the comparison of variables, differences were found in the mean weight, being greater in men than in women ($p = 0.008$), and in height, with a difference of almost 10 cm more in men than in women (1.67 ± 0.1 versus 1.56 ± 0.1 , respectively) ($p=0.000$). No significant differences were observed when comparing by gender in the variables age ($p = 0.673$), waist circumference ($p = 0.251$) and BMI ($p = 0.055$) (Tab. III).

DIETARY ENERGY INTAKE

The mean dietary energy intake was almost 3000 kcal/capita/day. In more than 50% of the participants, energy availability was over 3000 kcal/capita/day and around 20% have an average intake of 2200 kcal/capita/day. A difference of 500 kcal/capita/day was found between the mean energy consumption of men and women. The average distribution of macronutrients was as follows: 12.2%, 46.9%, and 40.9% for proteins, carbohydrates and total fats, respectively. We observed a greater consumption for all macronutrients among men; however, women maintained significantly higher adequacy values in energy and lipids, equal to 30% and 85%, respectively. Dietary fibre and sodium were within the recommended ranges for the total sample; however, regarding sodium, men have an average consumption of almost 22% more than recommended (Tab. IV).

Tab. II. Distribution of nutritional status, cardiovascular risk and non-communicable diseases. Number (n) and percentage (%). According to total sample and by gender.

	Total	Men	Women
Normal: n (%)	43 (21.5%)	15 (29.8%)	29 (19.0%)
Overweight: n (%)	70 (35%)	16 (34.0%)	54 (35.3%)
Obesity: n (%)	87 (43.5%)	17 (36.2%)	70 (45.7%)
Low Cardiovascular Risk: n (%)	45 (22.5%)	24 (51.1%)	21 (13.7%)
Moderate Cardiovascular Risk: n (%)	42 (21.0%)	13 (27.7%)	29 (19.0%)
High Cardiovascular Risk: n (%)	113 (56.5%)	10 (21.3%)	103 (67.3%)
Presence of Non-communicable Diseases	75 (37.5%)	18 (38.3%)	57 (37.3%)
Does not have Non-Communicable Diseases	125 (62.5%)	29 (61.7%)	96 (62.7%)
High blood pressure	51 (44.3%)	16 (31.4%)	35 (68.6%)
Diabetes Mellitus	32 (27.8%)	6 (18.8%)	26 (81.3%)
Dyslipidaemia	21 (18.3%)	3 (14.3%)	18 (85.7%)
Other diseases* (HT-AKF-CKF-ASTHMA)	11 (9.6%)	2 (18.2%)	9 (81.8%)

*HT: Hypothyroidism; AKF: Acute kidney failure; CKF: Chronic kidney failure.

Tab. III. Distribution of anthropometric measurements. Mean and Standard Deviation (SD). According to total sample and by gender.

Anthropometric measurements	Total	Men	Women	95% CI*	p
Age: mean (SD)*	43.5 (16.1)	44.7 (16.9)	43.2 (15.9)	2.68 - 6.43	0.673
Weight (kg): mean (SD)*	75.2 (13.8)	79.8 (14.6)	73.8 (13.2)	2.25 - 10.51	0.008
Height (m): mean (SD)*	1.59 (0.1)	1.67 (0.1)	1.56 (0.1)	0.01 - 0.13	0.000
Waist circumference (cm): mean (SD)*	92.3 (12.1)	94.1 (11.4)	91.8 (12.3)	2.02 - 6.31	0.251
Nutritional status (IMC): mean*	29.9	28.7	30.2	-3.43-.035	0.055

*SD: Standard deviation; CI: Confidence interval for the difference.

When making associations between the variables, a dependence between nutritional status, cardiovascular risk, dietary energy intake and the presence of non-communicable diseases was noted. Depending on the nutritional status, the presence of obesity is associated with high cardiovascular risk ($p = 0.000$), greater dietary energy intake ($p = 0.012$), and an increased occurrence of non-communicable diseases ($p = 0.004$) (Tab. V). It was found that old age and high cardiovascular risk were associated with a higher prevalence of NCDs ($p = 0.000$ and $p = 0.001$, respectively). No direct relationship was observed between age and dietary energy intake; age and CVR; and between energy intake and CVR.

Discussion

Data assessment shows that the occurrence of malnutrition is overwhelming, with a prevalence of obesity in almost 50% of the total sample. Overweight is dominant in both genders (78.5%), but in the case of women it reaches 80%. Lower values were found in

the National Health and Nutrition Examination Survey (NHANES 2014), where obesity reached 37.7%, being higher in women (40.4%) than in men (35.0%) [13]. The prevalence of obesity increased significantly among adult men and women in the United States; further significant increases were observed through 2003-2004 for men but not women. Subsequent comparisons of data from 2003-2004 with data through 2011-2012 showed no significant increases for men or women. To examine obesity prevalence for 2013-2014 and trends over the decade from 2005 through 2014 adjusting for sex, age, race/Hispanic origin, smoking status, and education. Analysis of data obtained from the National Health and Nutrition Examination Survey (NHANES) on the other hand, the prevalence of overweight was significantly lower among adults from 20 European countries, reaching 53.1%. The highest numbers were found in Hungary (61.6%), the Czech Republic (60.1%), and Lithuania (59.6%), as opposed to countries such as Switzerland (43.3%), France (45%), and Denmark (45.2%), with lower rates of overweight and obese people. Unlike what was found

Tab. IV. Distribution of nutritional adequacy of the diet. Macronutrients, fibre and sodium /capita / day. Energy (kcal), grams (g), and percentage (%). According to total sample and by gender (kcal; g; %).

Energy intake (kcal)	Amount (n)	%	Kilocalories mean (SD)*	Proteins (g) mean (SD)	Carbohydrates (g) mean (SD)	Lipids (g) mean (SD)	Fibre (g) mean (SD)	Sodium (mg) mean (SD)
< 2200	43	21.5	1840.1 (215.24)	60.8 (16.06)	227.5 (48.39)	77.7 (24.02)	21.9 (7.61)	1271.3 (721.79)
2201-3000	64	32	2587.3 (218.90)	79.4 (21.38)	317.3 (47.67)	112.9 (25.55)	26 (6.59)	1668 (778.15)
> 3000	93	46.5	3615.7 (473.31)	109.4 (31.72)	413.2 (99.22)	172.2 (47.82)	31.7 (14.16)	2454 (1106.50)
Total	200	100	2904.8 (801.27)	89.4 (32.56)	342.6 (105.7)	132.9 (53.80)	27.8 (11.60)	1947.9 (1054.28)
Energy and nutrients requirement Total sample			2119.6	79.5	291.4	70.7	30	< 2000
Men	47	23.5	3298.9 (788.85)	107.8 (34.59)	400.2 (123.33)	144.6 (52.84)	29.7 (9.53)	2448.3 (1223.39)
Women	153	76.5	2783.8 (767.76)	83.7 (29.80)	324.9 (93.13)	129.3 (53.75)	27.2 (12.14)	1794.3 (949.25)
Adequacy for energy and nutrients requirements Total sample (%)			138%	113%	118%	188%	93%	97%
Adequacy Men			130%	113%	115%	171%	99%	122%
Adequacy Women			140%	112%	119%	195%	91%	90%

Tab. V. Associations. Pearson's Chi Square.

Energy consumption							
		< 2200	2201-3000	> 3000	Total	X2	p
Age	18-39	17	28	44	89	1.365a	0.850
	40-64	20	26	39	85		
	≥ 65	6	10	10	26		
Total		43	64	93	200		
Cardiovascular Risk							
		Low CVR	Moderate CVR	High CVR	Total	X2	p
Age	18-39	23	22	44	89	4.971a	0.290
	40-64	17	13	55	85		
	≥ 65	5	7	14	26		
Total		45	42	113	200		
Diseases							
		None	1	2 or more	Total	X2	p
Age	18-39	77	10	2	89	47.802a	0.000
	40-64	42	23	20	85		
	≥ 65	6	10	10	26		
Total		125	43	32	200		
Energy consumption							
		< 2200	2201-3000	> 3000	Total	X2	p
Cardiovascular Risk	Low CVR	7	16	22	45	2.633a	0.621
	Moderate CVR	11	15	16	42		
	High CVR	25	33	55	113		
Total		43	64	93	200		
Non-communicable diseases							
		None	1	2 or more	Total	X2	p
Cardiovascular Risk	Low CVR	34	9	2	45	18.912a	0.001
	Moderate CVR	34	3	5	42		
	High CVR	57	31	25	113		
Total		125	43	32	200		
Cardiovascular Risk							
		Low CVR	Moderate CVR	High CVR	Total	X2	p
Nutritional Status	Normal	19	16	9	44	46.520a	0,000
	Overweight	20	15	34	69		
	Obese	6	11	70	87		
Total		45	42	113	200		
Energy consumption							
		< 2200	2201-3000	> 3000	Total	X2	p
Nutritional Status	Normal	15	18	11	44	12.866a	0.012
	Overweight	12	24	33	69		
	Obese	16	22	49	87		
Total		43	64	93	200		
Non-communicable diseases							
		None	1	2 or more	Total	X2	p
Nutritional Status	Normal	32	8	4	44	15.306a	0.004
	Overweight	50	14	5	69		
	Obese	43	21	23	87		
Total		125	43	32	200		

in this sample, men were more overweight than women (44.7% versus 30.5%) [14].

According to data published by the MINSAL (Ministry of Health), overweight in Chile has increased from 64.4% to 71% during the last 7 years [5, 15]; globally, the prevalence of obesity has doubled in more than 70 countries over the last 30 years and keeps rising steadily [16].

Obesity, besides increasing central distribution of adipose tissue, among other complications, increases morbidity [17], since it leads to a greater incidence of diseases that affect multiple organs, such as CVD, DM2, HBP, among others [18, 19].

With respect to diet, 76% of the sample had an energy intake higher than their requirements (> 110%), and 57% had high CVR (cardio-metabolic risk); these data

are consistent with what was stated by FAOSTAT in relation to dietary energy intake, which in Chile reaches an average of 3029 kcal/day [20], and 2929 kcal/day worldwide [21]. Additionally, in a cohort of adults in the United States (USA), a positive association was found between the intake of a diet high in low-quality carbohydrates and an increase in WC, with a mean of 92.6 cm [22].

About 80% have a high lipid intake (> 110% adequacy), with a mean consumption of 133 g/capita/day, corresponding to 40% of the daily energy value. Similar values were found in adults from the USA between 1971-1975 in the NHANES, with lipids intake ranging from 36 to 37.5%; by 2016, a decrease to 33.2% was observed [23]. In addition, high fat consumption has been associated with weight gain, but the effect of fats on lipoprotein levels varies depending on the type of fat consumed. Several studies have associated the consumption of trans fats with an increased risk of CVD, atherosclerosis, sudden death, DM2, non-alcoholic fatty liver disease, dysbiosis.

There are studies indicating that the Chilean population maintains a low consumption of health-protective foods [7, 20]. In addition, it is clear that in Chile [24], as well as in countries from Europe [25, 26] and America [27-29] among others [30], there have been changes in the dietary habits and consumption patterns, shifting from traditional diets to processed and ultra-processed foods [31, 32] mainly in urban households, affecting the health of the population, a situation that is observed in Chiloé, where the diet has gone through significant transformations [8].

Conclusions

It has been shown that a restriction of dietary energy intake and weight reduction positively contribute to lower blood pressure [33-35], as well as moving towards a Mediterranean diet and practising physical activity may lower high blood sugar levels. Malnutrition by excess figures support the global alert for obesity and overweight, which are considered to be a pandemic; in addition, Chiloé is not immune to the increasing trend of processed and ultra-processed food consumption.

LIMITATIONS

Since the study was conducted on a convenience sample and data were collected from two family healthcare centres of the two aforementioned communes, and from patients who were seen at the centres and voluntarily agreed to participate, results are only valid for the sample in question.

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Conflicts of Interest

The authors declare no conflict of interest.

Authors' Contributions

M.C. and M.J.S. share responsibility for the conceptualization, methodology, software use, formal analysis, resources, data curation, writing – original draft preparation, redaction – review and editing, visualization, supervision, project administration, funding acquisition.

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