Nutrición Hospitalaria

Original / *Otros*

Study on the mortality in Ecuador related to dietary factors

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Abstract

Diet is an important factor related to the development of numerous diseases. In developing countries like Ecuador, this aspect is not considered as priority however, the study of the incidence of certain diet-related diseases could help to assess consumption habits of a country from a Public Health perspective and support national nutrition policies and programs. The objective the present study is to investigate the mortality rate of certain diet-related diseases in Ecuador and its possible relationship with Ecuadorian consumption habits. For that, mortality rates (2001-2008) associated with five different disease groups related to dietary factors (cancer of colon, cerebrovascular diseases, cardiovascular diseases, diabetes mellitus and liver diseases) were collected, analyzed and compared to consumption patterns in Ecuador. According to results, Ecuador has a low level of cancer of colon in comparison with developed countries (e.g. Spain). The group with the highest number of deaths corresponded to cardiovascular diseases followed by cerebrovascular diseases. The mortality study per province revealed that Amazonian provinces showed few deaths in relation to other provinces in Ecuador. This could be due to different factors including fails in the disease surveillance information systems, environmental factors and consumption patterns. In this sense, further investigation on native products consumption such as "chontaduro" might help to find valuable foods contributing to healthier Ecuadorian diet. These results, though preliminary, evidence that a major effort should be made by national and international organisations to collect data on consumption patterns and nutritional aspects of the Ecuadorian population in order to better support the development of effective food security and nutrition policies.

(*Nutr Hosp.* 2013;28:1732-1740)

DOI:10.3305/nh.2013.28.5.6755

Key words: *Cancer of colon. Diet-related diseases. Consumption patterns. Amazonian foods. Cardiovascular diseases. Dietary factors.*

ESTUDIO SOBRE LA MORTALIDAD EN ECUADOR RELACIONADA CON FACTORES DE LA DIETA

Resumen

La dieta es un factor importante en el desarrollo de numerosas enfermedades. En países en vías de desarrollo como Ecuador, este aspecto no se considera como prioridad sin embargo el estudio de la incidencia de ciertas enfermedades relacionadas con la dieta podría ayudar a evaluar los hábitos alimentarios de un país desde una perspectiva de salud pública y apoyar el desarrollo de políticas y programas nacionales de nutrición. El objetivo de este trabajo es estudiar las tasas de mortalidad de ciertas enfermedades relacionadas con la dieta en Ecuador y su posible relación con los hábitos alimentarios Ecuatorianos. Para ello, las tasas de mortalidad (2001-2008) asociadas con 5 grupos de enfermedades relacionadas con la dieta (cáncer de colon, enfermedades cerebrovasculares y cardiovasculares, diabetes mellitus, y enfermedades hepáticas) fueron recopiladas, analizadas y comparadas con los patrones de consumo de Ecuador. Los resultados indicaron que Ecuador tiene un bajo nivel de cáncer de colon en comparación con países desarrollados (por ej. España). El grupo con el mayor número de muertes correspondió a enfermedades cardiovasculares seguido por enfermedades cerebrovasculares. El estudio de mortalidad por provincia reveló que las provincias de la Amazonía presentaron pocas muertes en relación con otras regiones. Esto podría deberse a múltiples factores incluyendo deficiencias en los sistemas de vigilancia epidemiológica, factores ambientales, y hábitos de consumo. En este sentido, se evidencia una necesidad de investigar con mayor profundidad alimentos nativos tales como el "chontaduro" ya que estos podrían contribuir de manera significativa al fomento de una dieta ecuatoriana más saludable. Estos resultados, aunque preliminares, evidencian que aún se deben realizar grandes esfuerzos en la recopilación de datos sobre patrones de consumo y aspectos nutricionales de la población ecuatoriana. Su existencia posibilitará el desarrollo de políticas más efectivas de seguridad alimentaria y nutrición.

(*Nutr Hosp.* 2013;28:1732-1740)

DOI:10.3305/nh.2013.28.5.6755

Palabras clave: *Cáncer de colon. Enfermedades relacionadas con la dieta. Hábitos de consumo. Alimentos de la amazonía. Enfermedades cardiovasculares. Factores de la dieta.*

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Introduction

Currently, overfeeding, nutritional quality of foods and consumption patterns are leading to serious problems in the World population.[1] However, the food security is a prime concern for governments of developing countries and international organizations. In this respect, it is recognized that diet is an important factor in the development of certain diseases: colon cancer, diabetes, cardiovascular diseases, liver diseases, and cerebrovascular diseases.[2-4-5-6] From that, the prevalence of these diseases can be a good indicator of the quality of the diet of a certain population. The report by WHO[7] indicated that different diet factors contributes in the appearance of chronic disease such as diabetes, cardiovascular diseases and determined types of cancer. These diseases, which can be related, in certain extent, to consumption patterns or nutritional components in the diet, have not been considered priority in developing countries because of the existing resources are mainly intended to basic and urgent needs of the population. To correctly manage social-economic policies, countries such as Ecuador should possess major knowledge on consumption patterns, food availability and nutritional characteristics of the population while improving welfare and health of the population.

Assessing the role playing the consumption of native fruits in the nutritional status of Ecuadorian population and its protective effect against certain diet-related diseases could help to increase the value of the Ecuadorian diet and specifically to enhance the consumption of those indigenous foods showing a high nutritional value and/or health-beneficial activity. In addition, this knowledge would be crucial to promote a sustainable development of rural regions in Ecuador based on the production, use and commercialization of these foods.

Therefore, this study aims to analyze the incidence of five disease groups related to diet factors in Ecuador, establishing differences between different Ecuadorian provinces to identify possible risk factors related to diet. On the basis of the different types of diseases considered in the report by WHO[7] and the availability of morbi-mortality information in the INEC (National Institute of Statistics and Census of Ecuador),[8] the selected diseases related to diet factors corresponded to cardiovascular diseases, cerebrovascular disease, diabetes, liver diseases and cancer of colon.

Materials and methods

Geopolitical description of Ecuador

Ecuador is a country located in the North-east of South America, bounded by Colombia to the North, by Peru to the South and East by the Pacific Ocean to the West. It has an extension of 256,370 km² and a population of more than 14 million of habitants crossed from North to South by a volcanic section of the Andes. To the West of the Andes is located the Guayaquil Gulf and a woody plain, and to the East, The Amazon. Currently, Ecuador is divided into 24 provinces from which two provinces have been recently created (Santo Domingo and Santa Elena) which do not have official information, so their data were included in the Pichincha and del Guayas provinces, respectively.[9]

Data sources for epidemiological and consumption patterns information

In order to determine the incidence of diseases related to diet, statistical tables of mortality of Ecuador, detailed per province, were collected from the national data base of the INEC (National Institute of Statistics and Census of Ecuador)[8] in the period of 2001-2008. Diseases with proven link to diet were selected from the collected tables.[2-4-5-6] Once diseases were selected, they were grouped according to criteria of pathogenicity and etiology based on official codification. The considered disease groups and diseases included in each of them are shown in table I.

To evidence the relationship between food intake and the incidence of the selected disease groups, the values of mortality per 100.000 inhabitants in 2005-2007 from different countries were used taken from national information systems. The countries were Argentina[10] Colombia,[11] Ecuador,[8] United States,[12] Europe (Germany, Spain, France, Italy and Portugal).[13] The mortality rates were compared with figures published by FAO (Food and Agriculture Organization)[14] concerning nutritional indicators and their contribution to the diet of the different countries.[15] The purpose was to suggest links between food intake and mortality incidence for the different disease groups. Furthermore, that information was contrasted with a survey carried out at the Technical State University of Quevedo (UTEQ) by the Agrofood Engineering School[15] about consumption patterns in Ecuador.

Statistical analysis

The mortality data were statistically treated considering the overall country, the disease group, and year. The mortality data was expressed as the annual mortality per 100,000 inhabitants. The statistical treatment was performed by means of the software Statgraphic® (Statpoint Technologies, Inc., Virginia). To establish the behaviour of the five disease groups in Ecuador, an Analysis of Variance was applied with a randomized complete block (RCB) design, considering as treatments five disease groups (table I) and eight blocks corresponding to data recorded for 8 years

Table I
Diseases groups responsible for dead cases related to dietary factors according to pathogenicity and Etiology criteria

Disease groups	Diseases according to ICD codification*
1. Cancer of colon	C18 Colonrectal cancer
2. Cerebrovascular diseases	I60- Subarachnoid haemorrhage
	I61- Intracerebral haemorrhage
	I62- Other nontraumatic intracranial haemorrhage
	I63- Cerebral infarction
	I64-Accidente vascular encefálico agudo, no especificado como hemorrágico o isquémico
	I66- Occlusion and stenosis of cerebral arteries, not resulting in cerebral infarction
	I67- Other cerebrovascular diseases
	I74- Embolism and thrombosis of abdominal aorta
	I77- Other disorders of arteries and arterioles
3. Cardiovascular diseases	I10- Essential (primary) hipertensión
	I21- Acute myocardial infarction
	I50- Heart failure
	I70- Atherosclerosis
4. Diabetes	E11- Non-insulin-dependent diabetes mellitas
	E14- Unspecified diabetes mellitus
5. Liver diseases	C22- Malignant neoplasm of liver and intrahepatic bile ducts
	C23- Malignant neoplasm of gallbladder
	K75- Other inflammatory liver diseases
	K74- Fibrosis and cirrhosis of liver

*International Classification of Diseases (ICD). Available from: http://www.who.int/classifications/icd/en/

(2001-2008). The annual mortality rate due to each disease group was considered as the variable. The analysis of each disease group was performed, separately. This statistical design has the advantage of an easy application, besides it allows using a higher number of treatments.[16]

The relationship between the incidence of the disease groups and food intake were assessed by performing a Pearson correlation (r) and linear regression analysis reporting the coefficient of determination (R^2), which were carried out with SPSS 17 for Windows (IBM, Spain). These analyses were applied to the mortality rates for Argentina, Colombia Ecuador, The United States, Spain, Italy, Germany, Portugal and France versus intake of fat, fruit, protein and rice (g/person/day) published by FAO for the period 2005-2007.[14]

To determine the incidence of the selected disease groups in Ecuador, the mortality rate per province were analyzed. In this case, only the time period 2006-2008 was analyzed since no complete and consistent data were available for prior years (< 2006). For the analysis, a randomized block designs were considered with the blocks corresponding to three annual (B1 = 2006, B2 = 2007 and B3 = 2008) and the 22 provinces were considered as treatments. The objective was evaluated possible differences between provinces which could be related to climatic and cultural factors and food availability, among others. The difference among means for treatments were assessed by the Tukey test with a level of significance of $P \leq 0.05$.

Results and discussion

The study of the annual evolution of the selected five diseases groups in Ecuador

The highest mortality rate during the period 2001-2008 corresponded to cardiovascular diseases, followed by cerebrovascular, diabetes mellitus, liver diseases and finally cancer of colon (table II). Also, it was observed that cancer of colon remained steady at very low levels during the analyzed 8 years. In the case of the cardiovascular diseases, a slight decrease was found in years 2003 and 2004. This fact can be attributed to eventual difficulties to record death cases. In contrast, diabetes mellitus showed a slight decrease in the last three years. Besides, the average mortality rates for the period 2001-2008 were significantly different for the five disease groups ($P < 0.05$). The Tukey test identified four homogenous groups ($P < 0.05$). The highest mortality rate was observed for cardiovascular diseases (49.5) followed by cerebrovascular diseases (22.3) and diabetes mellitus (17.8), liver diseases (12.6) and finally cancer of colon (2.2).

If we consider the incidence of the whole of diseases over 8 years, a higher mortality in 2002 was reported in relation to other years. No explanation was found to account for this unusual and specific increase, even though this fact can be related to differences in the data collection methodology used by the health information surveillance system.

By comparing the incidence of the diseases with data from Colombia and Argentina, The United States and

Year	Cancer of colon	Cerebrovascular diseases	Liver diseases	Diabetes	Cardiovascular diseases
2001	2.1	24.2	13.5	20.4	56.8
2002	1.9	25.5	13.1	18.7	61.1
2003	2.1	23.7	13.4	19.5	53.6
2004	2.3	22.7	14.0	20.2	49.1
2004	2.5	23.3	14.8	20.1	50.6
2006	1.9	19.5	12.0	13.5	38.7
2007	2.6	18.4	12.2	15.0	42.6
2008	2.6	21.6	12.5	15.4	44.1
Average*	2.2[a]	22.3[c]	13.1[b]	17.8[c]	49.5[d]

Source: INEC (8).
Letters in the average column represent homogenous groups reported by Tukey HSD test (P = 0.05).

Spain (fig. 1) it can be observed that cancer of colon in Ecuador, with 2.2 death cases/100,000 individuals, was below the mean in Colombia (7.41), Argentina (15.59), The United Sates (17.7) and Spain (15.3). With regard to the cardiovascular diseases, the incidence in Ecuador was also lower (49.5 death cases/100,000) than Argentina, Colombia and The United States, but not Spain, which showed a higher mortality rate (54.9). In the case of diabetes mellitus, cerebrovascular and liver diseases, there was no significant difference.

Study of the relationship between food intake and mortality rates of cancer of colon related to diet

A correlation analysis were carried out between mortality rates of different countries (i.e. Argentina, Colombia, Ecuador, The United States, Spain, Italy, Portugal and France) and food intake data published by FAO[14] during the period 2005-2007 (fig. 2). This analysis found a significant correlation between cancer of colon and the low intake of protein ($r = 0.897$; $R^2 = 0.85$), fat ($r = 0.714$; $R^2 = 0.51$) and the high consumption of fruits and vegetables ($r = -0.804$; $R^2 = 0,646$) and rice ($r = -0.940$; $R^2 = 0.799$). Although there was significant correlation for protein and fat intake, scientific studies do not provide clear evidences supporting these dietary factors as risk factors increasing cancer of colon incidence.[17-18] In contrast, several studies have suggested that intake of fruits and plant foods rich in fiber has a negative association with the incidence of cancer de colon (i.e. increasing the intake reduces cancer of colon incidence).[19-20] These data would indicate that consumption of fruits and rice in Ecuador can positively affect the low incidence of the cancer de colon. Nonetheless, that statement should be considered carefully since other confounding factors can be affecting the relationship between fruit consumption and incidence of cancer of colon such as lifestyle and other environmental factors.
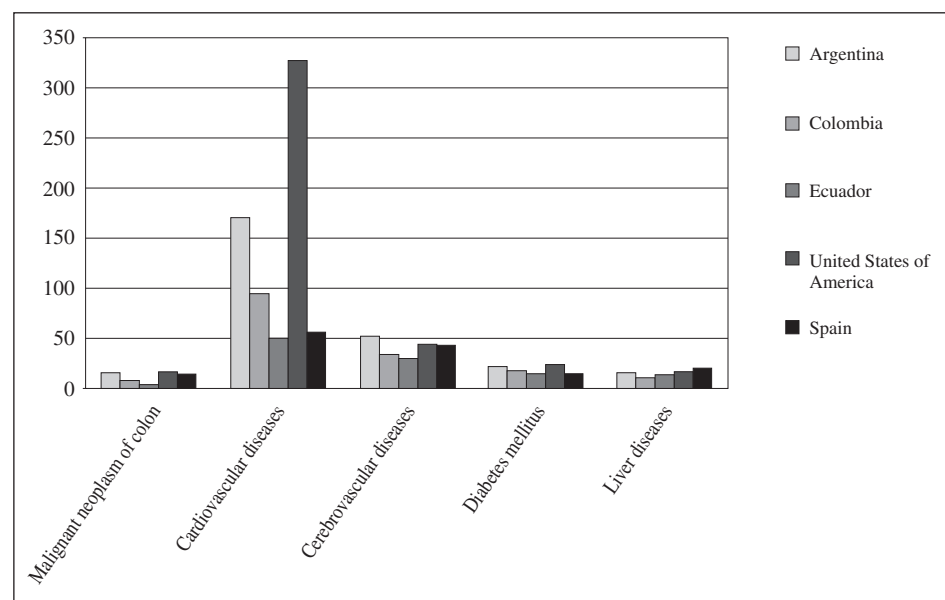

Fig. 1.—Mortality rate (deaths per 100,000 individuals per year) of the five disease groups in the period 2005-2007 for different countries (Argentina, Colombia, Ecuador, United of States, and Spain).
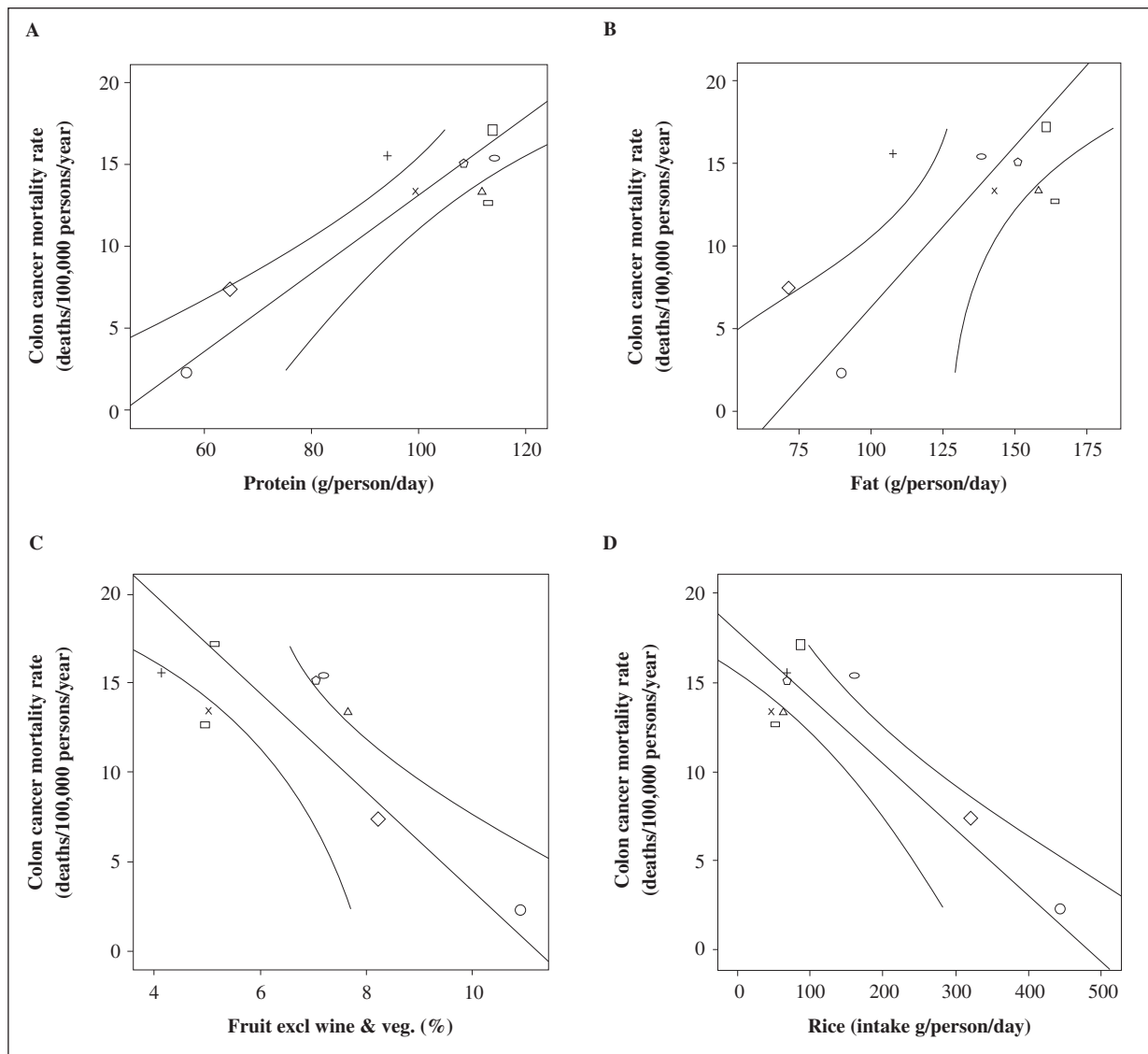
Fig. 2.—Data on colon cancer mortality rates (deaths per 100,000 individuals years) plotted against daily consumption of (A) Protein, (B) Fats, and (C) Fruits excl Wine & Veg. and (D) Rice in different countries (+ Argentina; ◊ Colombia; Ecuador. France; × Germany; Italy; Portugal; Spain; United States of America) with fitted linear model (dashed line) and upper and lower limits (solid lines) of the 95 % confidence interval.

Study of the fat intake in Ecuador and comparison with other countries

The total fat intake in Ecuador was 89 g/person/day during 2005-2007 (fig. 6), which is above the intake values reported for neighbour countries such as Peru and Colombia but below the levels in Spain (151 g/person/day), The United States (161 g/person/day) and Argentina (108 g/person/day) (fig. 3). Likewise, as shown in figure 1, Ecuador has a high mortality rate of cardiovascular diseases. This fact might suggest certain relationship with the palm oil consumption, which represents the major dietary sources of vegetable oil in the Ecuador.[14] It is a matter of fact that the relationship between health and fat intake does not depend on the ingested amount but rather of the quality of the fatty acids profile of diet, which could have be linked to the appearance of cardiovascular diseases.[21-22] By analyzing the contribution of different foods to the fat intake (2005-2007),[14] it can be observed that intake of palm oil in Ecuador is much higher (i.e., 235 Kcal/person/day) than those reported by the other countries included in the present work (fig. 4). The high levels of saturated fat (i.e. palmitic acid) in palm oil can be considered as a contributory factor causing cardiovascular diseases,[23,24] which could help to support the hypothesis of the existence of a relationship between fat intake and the high incidence of cardiovascular diseases in Ecuador. As the lack of information regarding this issue in Ecuador, no clear conclusions cannot be given, hence further research should be carried out in order to clarify which possible diet
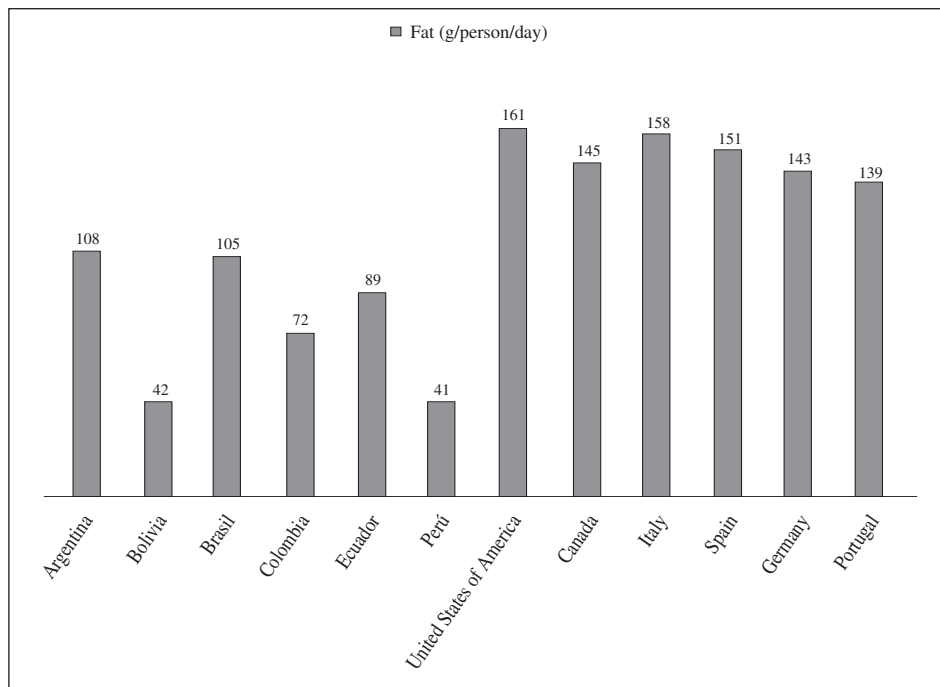
Fig. 3.—Fat intake (g/persona/day) in Ecuador and other countries for the period 2005- 2007 according to FAO (1).
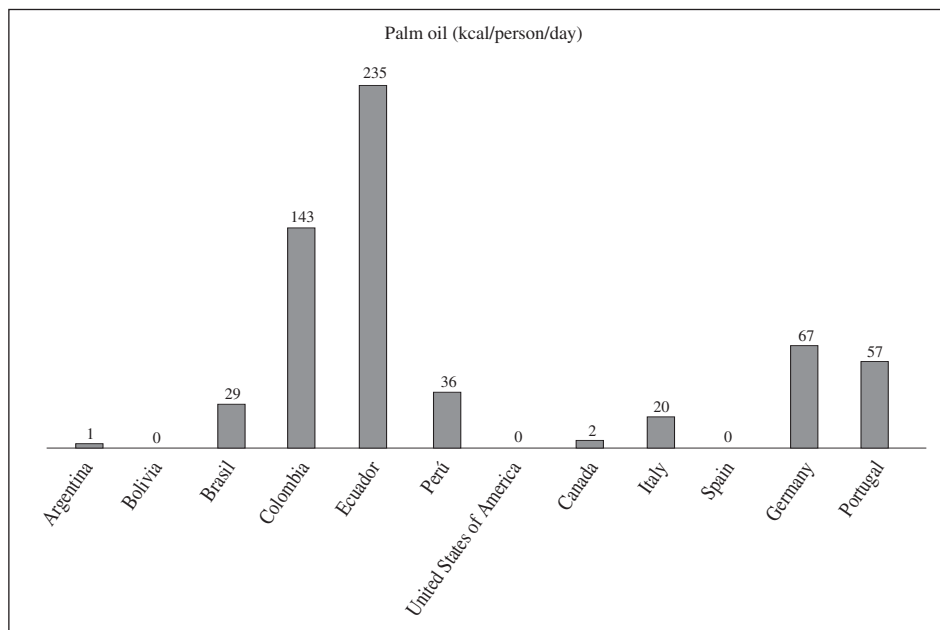

Fig. 4.—Palm oil intake in Ecuador and other countries for the period 2005-2007 according to FAO (1).

factor(s), if related with diet, are more involved in the incidence of cardiovascular diseases in Ecuador.

Study on the mortality rate per province in the period 2006-2008

With regard to the mortality rate obtained per province (22 provinces considered in this study), in the table III, it can be observed that mortality rates for cancer of colon are low and similar for all provinces in the period 2006-2008. In accordance with a survey carried out by UTEQ,[15] the most consumed foods in the Amazonian region are banana, rice, yucca and the fruit of *Bactris gasipaes* , which is named "chontaduro" in the native language. The latter is a native plant found in the "hoya amazónica", situated between Colombia, Peru, Brazil, Ecuador and Central America. The plant has been cultivated by the indigenous in the American tropic since pre-Columbian period, mainly for the consumption of its fruit.[25] The study by Pérez and Rojas et al.[26] found that carotenoids are at high levels in

Table III
Average mortality rates (dead cases/100,000 individuals) for the 5 diseases groups reported for the period 2006-2008 per province in Ecuador

Province	Cancer of colon	Cerebrovascular diseases	Liver diseases	Diabetes	Cardiovascular diseases
Azuay	2.7[a]	18.9[cdefgh]	15.4[de]	18.1[ef]	57.5[efg]
Bolívar	4.1[a]	26.9[ghijk]	16.2[de]	12.4[cd]	63.6[fgh]
Cañar	2.1[a]	14.7[abcdef]	16.0[de]	14.4[de]	53.5[efg]
Carchi	1.8[a]	42.3[k]	15.5[de]	20.4[fg]	61.8[fgh]
Cotopaxi	2.1[a]	29.4[hij]	16.8[e]	9.0[bc]	46.3[cdefg]
Chimborazo	2.8[a]	21.5[defghi]	17.3[e]	6.3[ab]	50.8[defg]
El Oro	4.1[a]	21.4[defghi]	17.8[e]	23.6[gh]	39.7[bcde]
Esmeraldas	1.7[a]	18.0[bcdefgh]	7.8[abcd]	16.0[def]	31.6[abcd]
Guayas	3.3[a]	24.0[efghij]	18.2[e]	31.7[i]	57.1[efg]
Imbabura	1.8[a]	29.6[hij]	12.6[abcde]	18.8[efg]	40.5[bcde]
Loja	3.1[a]	15.7[abcdefg]	17.0[e]	19.4[efg]	55.4[efg]
Los Ríos	3.1[a]	32.7[ijk]	16.9[e]	27.6[hi]	65.6[gh]
Manabí	2.3[a]	25.6[fghij]	15.0[cde]	26.3[h]	51.1[defg]
Morona Santiago	0.8[a]	6.1[ab]	5.8[a]	5.2[ab]	23.1[ab]
Napo	0.8[a]	12.5[abcde]	4.9[a]	8.5[bc]	18.1[a]
Pastaza	1.4[a]	7.1[abc]	4.6[a]	5.3[ab]	13.8[a]
Pichincha	3.1[a]	25.9[fghij]	12.4[abcde]	19.3[efg]	42.9[bcde]
Tungurahua	4[a]	34.5[jk]	14.9[bcde]	17.4[def]	82.4[h]
Zamora Chinchipe	2.4[a]	5.1[a]	7.7[abcd]	8.7[bc]	26.3[abc]
Galápagos	3.3[a]	4.8[a]	6.2[ab]	1.6[a]	13.6[a]
Sucumbíos	0.5[a]	10.4[abcd]	6.5[abc]	8.0[bc]	14.9[a]
Orellana	1[a]	9.6[abcd]	4.3[a]	4.0[ab]	10.6[a]

Source: INEC (8)

Letters in the same column represent homogenous groups reported by Tukey HSD test (P = 0.05).

"chotoduro". These substances have been suggested to have a protective effect against certain types of cancer including colon cancer.[27] The carotenoids that are present in the raw pulp of "chotoduro" include epoxi-α-carotene, 15-CEI α-carotene, All-trans α-criptoxantine, epoxi-β-carotene and lycopene. In relation to the banana consumption, it has been demonstrated that the vegetable sterols are protectors against colon carcinogenesis.[28] The main sources of phytosterols in Ecuador are corn, legumes, bananas and apples. Studies performed by Robles-Agudo et al.[29] explained that diets containing high levels of refined cereals increase the risk of cancer of colon so that their substitution by fruits and vegetables is recommended.[29]

The highest mortality rate of cerebrovascular diseases were found in "Carchi" (42.3) while "Galápagos" (4.8), "Zamora Chinchipe" (5.1), "Morona Santiago" (6.1) showed the lowest mortality rates. Interestingly, the provinces with the lowest levels belong to the Amazonian region and two to countryside zone of Ecuador, which are Cañar and Loja. Although there can be a number of factors responsible for such a low incidence, including deficiencies in the health information surveillance systems, it is worthy to underline that those

regions show a high consumption of "chontaduro" among other indigenous fruits and vegetables. In this respect, Orduz and Ranger[30] claimed excellent nutritional properties for the "chontaduro" especially because of the non-saturated fat component comprising: palmitoleic acid 5.3 to 10.5 %, oleic acid 40.6 to 50. 3 %, linoleic acid 1.4 to 12.5 % and linolenic acid 1.0 to 2.0 %.[31]

The highest mortality rate for liver diseases were observed in "Guayas" (18.2), "El Oro" (17.8), "Chimborazo" (17.3) and "Loja" (17), and "las Provincias Orellana" (4.3), "Pastaza" (4.6) and "Napo" (4.9) showed low mortality rates. In this case, the highest incidence is found in seaside provinces where there is a major alcoholic consumption according to data from FAO.[14] The death cases associated with cardio-vascular diseases have been mostly recorded in "Tungurahua" (82.4), while the low mortality rates have been found in "Orellana" (10.6), "Galápagos" (13.6) and "Pastaza" (13.8). On the other hand, diabetes mellitus showed a higher mortality rate in "Guayas" (31.7) and low rate in "Galápagos" (1.6), "Orellana" (4) and "Morona Santiago" (5.2). It is likely that the high mortality rate associated with diabetes in these provinces is a consequence of the more modern living style with respect to other regions
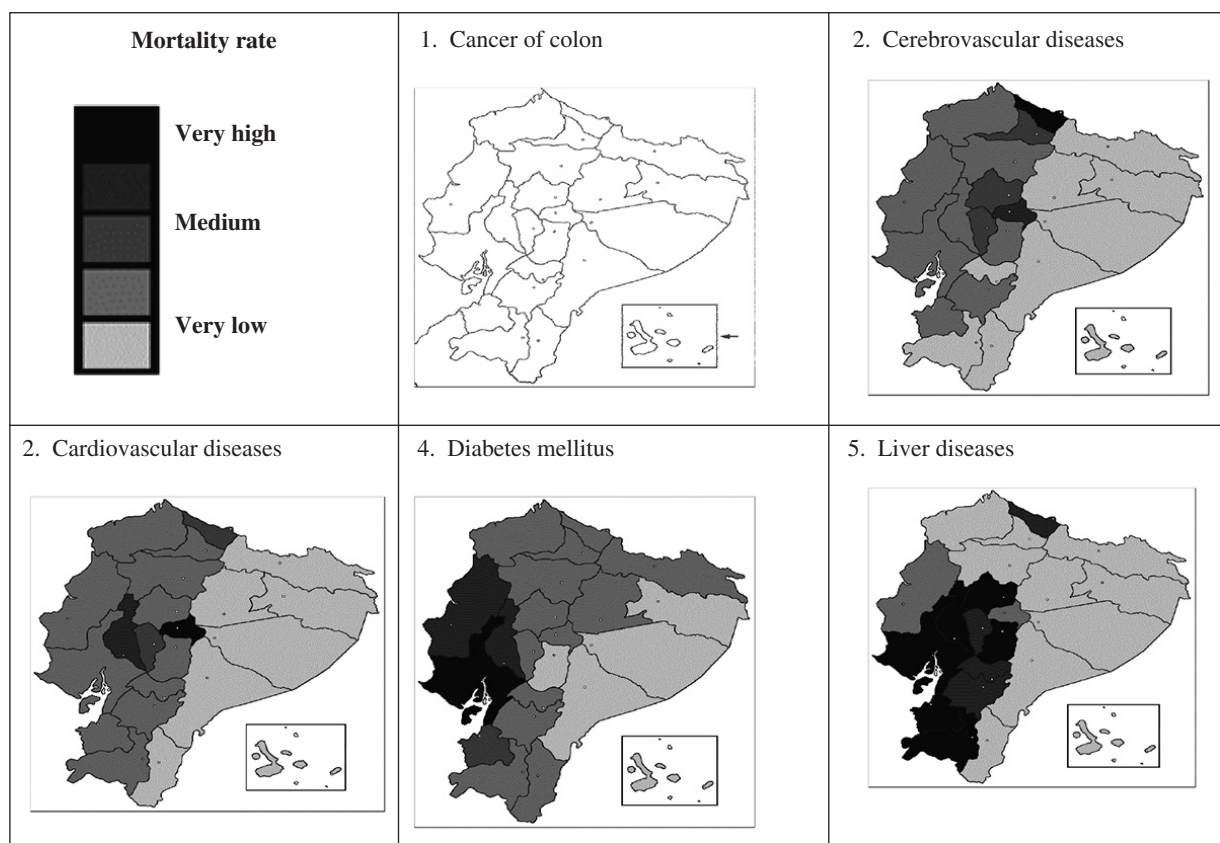
Fig. 5.—Mortatility rate map (deaths per 100,000 individuals per year) in 22 provinces of Ecuador for the five selected disease groups: (1) Cancer of Colon, (2) Cerebrovasculares diseases, (3) Cardiovascular diseases, (4) Diabetes Mellitus (5) Liver diseases (INEC, 2011).

(e.g. Amazon) (fig. 5). A study carried out by FAO[14] revealed that consumption patterns are changing in rural and countryside zones in Ecuador, including in the food list, more elaborated food products with a marked trend toward occidental diets. This fact is in concordant with the higher prevalence of Diabetes mellitus, cardiovascular and cerebrovascular diseases found in more developed provinces such as Guayas and Pichincha in contrast to the lower incidence in Amazonian provinces, where population is rather dedicated to farmwork.

Conclusions

In the present study, a serious lack of information on consumption patterns in Ecuador and its relationship with the incidence of certain diet-related diseases was detected. Nevertheless, a low mortality rate was observed for cancer of colon in comparison to those reported by both other Latin-American countries and developed countries. This result could suggest certain link between socio-cultural factors and dietary factors and the low incidence of the cancer of colon in Ecuador. In addition, the statistical study carried out per province evidenced significant differences between types of region in Ecuador. With relation to this, the Amazonian region showed lower incidence of cardiovascular, cerebrovascular and liver diseases, which can be associated with, among others, dietary factors such as the consumption of native foods (i.e. non-industrialized foods) highlighting "chontaduro" as its high nutritional quality. The results in this study, though preliminary, allow to evidence different aspects of great importance for the Public Health of Ecuador, which should be addressed in future and more specific investigations. In this sense, obtaining information on consumption patterns and nutritional aspects of the Ecuadorian population will be crucial to better support the development of effective food security policies in Ecuador.

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