Nutrición Hospitalaria

Nutr Hosp. 2013;28(3):726-733
ISSN 0212-1611 • CODEN NUHOEQ
S.V.R. 318

Original

Changes in body composition and cardiovascular risk indicators in healthy Spanish adolescents after lamb- (Ternasco de Aragón) or chicken-based diets

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Abstract

Objective: **To assess the effect of lamb consumption (Protected Geographical Indication (PGI), Ternasco de Aragón) on health indicators including body composition and cardiovascular risk indicators of healthy young Spanish students living in the area of Aragón, Spain.**

Methodology: **A randomized-controlled and cross-over trial (two periods of 8 weeks duration) assessing changes on body composition (body mass index and skinfold thicknesses) and cardiovascular risk indicators of 50 participants randomly assigned to follow a normocaloric diet with lamb (Ternasco de Aragón) or chicken. Body composition and serum cardiovascular risk profiles were measured both at baseline and follow-up.**

Results: **Healthy men (n = 22) and women (n = 28), aged 19.43 ± 0.85 years were studied. Suprailiac skinfold thickness and waist circumference significantly decreased ($p < 0.05$) in the lamb-consumption group compared to the chicken based diet group. No significant changes were observed in the rest of the variables in either group.**

Tryacilglicerol and insulin serum concentrations significantly decreased ($p < 0.05$) in the lamb-consumption group compared to the chicken based diet group.

Conclusions: **The results suggest that regular consumption of lamb (Ternasco de Aragón) can be integrated into a healthy, varied and well-balanced diet, as body composition and cardiovascular risk profile changes are similar or even healthier to those observed following chicken consumption.**

(*Nutr Hosp.* 2013;28:726-733)

DOI:10.3305/nh.2013.28.3.6382

Key words: *Lamb (Ternasco de Aragón). Poultry. Lipids. Obesity. Cardiovascular disease risk. Prevention. Adolescents. Nutrition.*

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Recibido: 27-XII-2012.
Aceptado: 8-I-2013.

CAMBIOS EN LA COMPOSICIÓN CORPORAL Y EN LOS INDICADORES DE RIESGO CARDIOVASCULAR EN ADOLESCENTES ESPAÑOLES SANOS DESPUÉS DE LA INGESTA DE UNA DIETA A BASE DE CORDERO (TERNASCO DE ARAGÓN) O POLLO

Resumen

Objetivo: **Evaluar el efecto del consumo de cordero (Indicación Geográfica Protegida (IGP), Ternasco de Aragón) en los indicadores de salud, incluyendo la composición corporal y los factores de riesgo cardiovascular en estudiantes españoles jóvenes y sanos que viven en la zona de Aragón.**

Metodología: **Se han evaluado los cambios producidos en la composición corporal y los factores de riesgo cardiovascular en dos períodos aleatorios, cruzados y controlados. 50 jóvenes fueron asignados aleatoriamente para seguir una dieta normocalórica con carne de cordero (Ternasco de Aragón) o el pollo. La composición corporal se evaluó a través de medidas antropométricas y el perfil de riesgo cardiovascular en suero se midió al inicio y después de consumir la carne de cordero o de pollo.**

Resultados: **Se ha estudiado una muestra compuesta por hombres sanos (n = 22) y mujeres sanas (n = 28), con edades comprendidas entre 19,43 ± 0,85 años.**

El pliegue cutáneo suprailíaco y la circunferencia de la cintura disminuyeron de forma significativa ($p < 0,05$) en el grupo de consumo de cordero y no en el de pollo. No se observaron cambios significativos en el resto de variables en los dos grupos. Las concentraciones de triglicéridos y las concentraciones séricas de insulina disminuyeron de forma significativa ($p < 0,05$) en el grupo de consumo de cordero y no en el de pollo.

Conclusiones: **Los resultados sugieren que el consumo regular de carne de cordero (Ternasco de Aragón) se puede integrar en una dieta sana, variada y equilibrada, ya que los cambios observados en la composición corporal y en el perfil de riesgo cardiovascular son similares o incluso más favorables en el grupo que consumió cordero que en el grupo que consumió pollo.**

(*Nutr Hosp.* 2013;28:726-733)

DOI:10.3305/nh.2013.28.3.6382

Palabras clave: *Cordero (Ternasco de Aragón). Aves de corral. Lípidos. Obesidad. Riesgo de enfermedad cardiovascular. Prevención. Adolescentes. Nutrición.*

Abbreviations

kg: Kilogram.
PGI: Protected Geographical Indication.
g: Gram.
h: Hours.
IPAQ-A: Adapted International Physical Activity Questionnaire.
cm: Centimeter.
mm: Millimeter.
BMI: Body mass index.
m: Meters.
$\sum$ 6 skinfolds: Sum of the six measured skinfold thicknesses.
LDL: Low-density lipoprotein cholesterol.
HDL: High-density lipoprotein cholesterol.
SPSS: Statistical Package for the Social Sciences.
ANOVA: Analysis of Variance.
CLA: conjugated linoleic acid.
SFAs: saturated fatty acids.
PUFA: polyunsaturated fatty acids.
n-6/n-3 ratio: the omega 6 fatty acids to omega 3 fatty acids ratio.

Introduction

Obesity is a great public health concern in the Westernized world, especially among children and young people, with over 97 million US people classed as obese or overweight.[1] In Spain, the prevalence of overweight and obesity among adolescents has increased from 13% and 16% in 1985 to 35% and 32% in 2000-2002, respectively.[2]

Dietary fat intakes are considered to be a determinant factor to the development of obesity leading to the design of low-fat diets for weight control and management and/or weight reduction.[3] Red meat, in particular lamb, is associated with high-total fat diets and high saturated fat content; therefore, public health recommendations encourage elimination or reduced lamb meat consumption. However, evidence suggest that plasma lipid profiles can be improved following a low-cholesterol diet including lean red meat as the major protein source; these studies compared lean red meat with fish or lean chicken in hypercholesterolemic individuals.[4,5,6,7] The results of another study indicated weight loss and improved lipid profile when lean beef or chicken were the main dietary protein sources in a sample of overweight women.[3]

The term *Ternasco de Aragón*, refers to a young lamb, fed with concentrated ad libitum and cereal straw, without distinction of sex, and corresponding to one of the following three native Spanish sheep breeds: Rasa Aragonesa, Ojinegra and Roya Bilbilitana. The *Ternasco de Aragón* is slaughtered with less than 90 days of life, and a carcass weight between 8.0 and 12.5 kilogram (kg). Products are regulated by the Protected Geographical Indication (PGI) Ternasco de Aragón (Denominación Específica *Ternasco de Aragón*. Diputación General de Aragón 10 de Junio de 1989, M.A.P.A. 22 de Septiembre 1992), and therefore, meet the established requirements of quality (Cumplimiento de la Norma Europea E.N. 45.011. Diputación General de Aragón, 1999).

The main objective of the present study was to compare the change effect of lamb *(Ternasco de Aragón)* versus commercial chicken consumption on body composition and cardiovascular risk indicators as part of a usual and balanced diet.

Materials and methods

Population

Participants recruited were between 16 to 25 years of age (n = 50 participants, 22 men and 28 women). Three university accommodation halls, two of them in the city of Teruel and one in the city of Zaragoza (Spain), were the recruitment settings. A study information sheet on the nature and purpose of the study was given to all participants and supervisors. Once written consent was obtained, participants were considered for inclusion in the study. Eligibility criteria included: free of any chronic, metabolic, endocrine or nutrition-related disease. In the medical history participants were required to report medical treatment. No participant reported to be currently enrolled in a weight loss program, or currently be taking any medications known to have a lipid-lowering effect.

Ethics

The study was performed in accordance with the Helsinki Declaration 1961 (revision of Edinburgh 2000) and was approved by the Research Ethics Committee of the Government of Aragón (Spain). A written informed consent was obtained from all participants and from their parents for those younger than 18 years.

Experimental design

The study was a randomized-controlled and cross-over trial consisting of two experimental periods with duration of 8 weeks respectively. Enrolled participants followed a normocaloric diet and were randomly assigned to a lamb *(Ternasco de Aragón)* or a chicken-based diet. The nutritional value of both diets was similar in both groups including sources of dietary proteins and fats. Participants following a chicken-based diet were instructed to consume 150 grams (g) of chicken, three times per week, and participants following a lamb-based diet were instructed to consume 150 g of boneless lamb (200 g with bones).

Table I
Cooking methods characteristics for both lamb and chicken

	Roasted	*Grilled*	*Stewed*
Olive oil	10 ml virgin olive oil	10 ml virgin olive oil	10 ml virgin olive oil
Cookin method	Gas oven	Simple grill	Stew
Internal temperature	75º C	75º C	75º C
Cooking temperature	200º C	200º C	180º C
Time of cooking	1 h 15 m	1 m	1 h 15 m
Additional foods	No	No	250 ml water 30 g chopped almonds
Part/piece	Whole chicken/lamb leg	Breast chicken/ lamb steak (leg)	Chicken pieces/lamb leg
Skin in chicken	Yes	No	Yes

The consumption of lamb was comparable to the consumption of chicken in the average Spanish homes. To ensure harmonisation, product-rich diets were served during lunch time and with each chef of the 3 designated university accommodation halls were given instructions on the cooking methods. Cooking methods are presented in table I.

The study design is presented schematically in Figure 1. During the 2 weeks before the first period, researchers contacted with participants in the three university accommodation halls and obtained informed consent of them. And after this, the first visit was scheduled in the morning hours where the medical history was applied and the first assessment of cardiovascular risk (first blood draw following a 12-hours (h) overnight fast), anthropometric, blood pressure (systolic and diastolic blood pressure) and heart rate measures were undertaken.

At the time of the first visit (experimental period 1), each participant was randomly assigned to a lamb *(Ternasco de Aragón)* or a chicken-based diet.

Following an 8-week period, participants were attended in the morning hours for a second visit and the second assessment of cardiovascular risk (second blood draw following a 12-h overnight fast), anthropometric, blood pressure (systolic and diastolic blood pressure) and heart rate measures were undertaken. Following the cross-over design, participants for the second 8-week period were crossed to the lamb *(Ternasco de Aragón)* or a chicken-based diet respectively.

Dietary assessment

To assess dietary compliance, participants were asked to complete four computer-assisted and self-administered 24 h dietary recall (HELENA-DIAT)[8]. Two recalls were obtained at the beginning of the 8 weeks period (either in the lamb *(Ternasco de Aragón)* or a chicken-based diet) and further two recalls at the end of the 8 weeks period (either in the lamb *(Ternasco de Aragón)* or a chicken-based diet). One of these recalls was obtained at the beginning of the study in each group, in order to assess the previous habitual diet of participants of both groups. As part of the dietary compliance assessment, the 24 h dietary recall was done too, in a random day, at the middle of each period.

Physical activity assessment

Physical activity was assessed via a self-administered questionnaire namely the Adapted International Physical Activity Questionnaire (IPAQ-A),[9] at the same time as the rest of measurements.

Washout period

A 5-week washout period took place after each experimental period to remove the possible residual effects of the preceding experimental diet on the blood variables tested [7]. Adolescents were instructed to main-

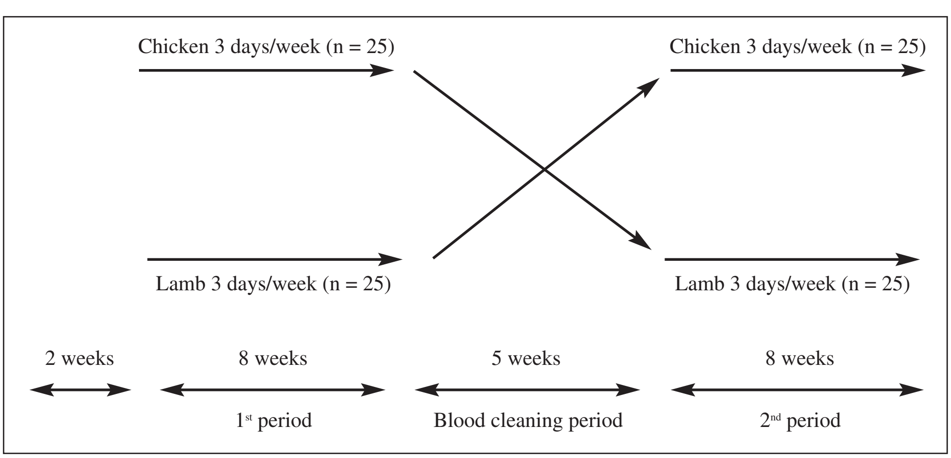

Fig. 1.—Subject flow and protocol for the study.

tain a healthy diet using the Food Guide Pyramid, and asked not to change their diet or activity habits for the 5-week washout period. As part of the experimental design, one 24 h dietary recall was done at the start of the 5-week washout period and a second 24 h dietary recall was done at the end of the 5-week washout period. According to 24 h dietary recalls, energy and macronutrient intake were not different between those consuming lamb or chicken at the starting of the second intervention period. After the cleaning period, a third complete set of measurements was obtained.

Anthropometric measurements

International guidelines for anthropometry in young population groups were applied.[10,11] Measurements were obtained by the same trained researcher.[11]

Body weight (kg): Body weight was measured with an electronic scale (SECA 861), precision 100 g, and range 0-150 kg. The instrument was calibrated and needed no further calibration. The adolescent stood on the platform of the scale without support, with the body weight evenly distributed between both feet. Light indoor clothing was worn, excluding shoes, long trousers and sweater. The weight of the clothing was not subtracted from the observed weight.

Height (centimeters, cm): The mean of three measurements, using a precision stadiometer (Seca 225), precision 0.1 cm and range 70-200 cm, was calculated. The adolescent stood straight in an upright position; feet together, knees straight, heels, buttocks and back touched directly the back part of the stadiometer. The head was positioned in the Frankfurt plane. Arms hanged relaxed on the side of the body, with the inner part of the hand facing the thigh. The mobile, horizontal part of the stadiometer touched the head of the participant, with a light pressure on the hair.

Skinfold thicknesses (milimeter, mm) were measured at the left side of the body to the nearest 0.2 mm with a skinfold caliper (Holtain, U.K., range 0-40 mm) and the mean of the three measurements was calculated. Measurements were taken at the following sites: 1) triceps, halfway between the acromion process and the olecranon process at the back side of the arm; 2) biceps, at the same level as the triceps skinfold, directly above the centre of the cubital fossa; 3) subscapular, about 20 mm below the tip of the scapula, at an angle of 45° to the lateral side of the body; 4) suprailiac, about 20 mm above the iliac crest and 20 mm towards the medial line; 5) thigh, in the midline of the anterior aspect of the thigh, midway between the inguinal crease and the proximal border of the patella; 6) calf, at the level of maximum calf circumference, on the medial aspect of the calf.

Circumferences were measured in centimeters with an unelastic tape to the nearest millimeter with the participant in a standing position. Five circumferences were measured. When measuring relaxed arm circumference, the participant stood relaxed facing the observer, and the arm hanging freely at the side; the tape was passed around the arm at the level of the midpoint of the upper arm. For measurements of the flexed upper arm circumference (biceps circumference), the participant contracted the biceps as much as possible, and the tape was passed around the arm so that it touched the skin surrounding the maximum circumference. To measure the waist circumference, the tape was applied horizontally midway between the lowest rib margin and the iliac crest, near the level of the umbilicus, at the end of gentle expiration. The hip circumference measurement was taken at the point yielding the maximum circumference over the buttocks, with the tape held in a horizontal plane. Proximal thigh circumference was measured just below the gluteal fold and perpendicular to its long axis; the participant stood erect with the feet slightly apart and the body mass evenly distributed between both legs.[11,12]

The complete set of anthropometric measurements was performed three times, but not consecutively; all the anthropometric variables were measured in order and then repeated for a second and a third time.

Body mass index (BMI) was calculated as body weight (kg) divided by height (meters, m) squared. And as an index of total adiposity, the sum of the six measured skinfold thicknesses ($\sum$ 6 skinfolds)[13,14] were calculated.

Laboratory analyses

Blood samples (total: 4 blood samples) were drawn via venipuncture by a registered nurse after a 12 h overnight fast. Samples were immediately shipped to the Clinical Analysis Service, Laboratory of Biochemistry of the General Hospital *"Obispo Polanco"* of Teruel. Standardized hospital laboratory procedures were used to analyze samples for total cholesterol, low-density lipoprotein (LDL) cholesterol, high-density lipoprotein (HDL) cholesterol, and triacylglycerols representing the study's measures of lipid profile. Glucose and insulin were also analyzed. Enzymatic methods using Synchron Systems, DXC 800, Beckman Coulter determined: total cholesterol (cholesterol oxidase), high-density lipoprotein (HDL) cholesterol (cholesterol esterase), glucose (glycerolkinase) and triacylglycerols (hydrolysis by lipase), Insulin was determined by radioimmunoassay (Axsym, Abbott Laboratories, Chicago, IL, USA).

Statistical analyses

All analyses were done using the Statistical Package for the Social Sciences (SPSS Version 15.0 for Windows; SPSS Chicago, ILC). Means and standard deviations were used to describe the magnitude and variability of outcomes. Outcome measures of partic-

Table II
*Baseline subjects characteristics**

	Total	*Chicken group*	*Lamb group*
N	50	50	50
Age (y)	19.489 ± 0.89	19.54 ± 0.95	19.43 ± 0.85
Height (cm)	167.070 ± 11.35	171.29 ± 8.70	163.17 ± 12.25
Weight (kg)	65.132 ± 11.93	68.41 ± 11.51	62.10 ± 11.72
BMI (kg/m^2)	23.0760 ± 3.55	23.46 ± 3.25	22.71 ± 3.84

*Data presented as mean ± standard deviation.
BMI: Body mass index.

ular interest included BMI, skinfold thicknesses, circumferences, sum of 6 skinfold thicknesses, blood lipid profile, glucose and insulin. The validity of the cross-over design was tested by a repeated measures model (Analysis of Variance, ANOVA), defining one two-level model, where the order of treatment was the between-participants factor and the differences in the dependent variables were the within-participants indicators. No significant differences in the studied variables were found indicating that the order did not affect the results of observed variables, with the exception of insulin. Group comparisons, i.e., the lamb *(Ternasco de Aragón)* or the chicken based diet were done with the parametric *t*-test for paired samples. The non-parametric Wilcoxon test was used for quantitative variables showing a non-Gaussian distribution. Changes of insulin levels were compared with the *t*-test for two independent groups. Findings were considered statistically significant at $p < 0.05$.

Results

Baseline characteristics of the study participants per experimental phase are presented in table II. Only one participant refused to be included in the study at the beginning of it, and before the assignment of experimental period. No participant dropped out from the study, and all of them followed a 100% of compliance or had an acceptable compliance (did not follow the diet exactly as offered in the university accommodation halls, but made acceptable modifications from the diet). In these circumstances, the registered dieticians helped the participant to increase compliance[3].

BMI and the sum of the 6 skinfold thicknesses did not change significantly in either group (table III). However, suprailiac skinfold thickness (p = 0.007) and waist circumference (p = 0.026) significantly decreased after lamb consumption (table 3).

Regarding lipid profile changes, plasma total cholesterol, HDL cholesterol and LDL cholesterol changes in the chicken-consumption group was not significantly different from changes in the lamb-consumption group. However, triacylglicerol concentrations significantly (p = 0.015) decreased after the lamb consumption (table IV).

Statistically significant changes in insulin levels over time were also found: the insulin significantly (p

Table III
*Body composition values: before and after the two interventions**

	Chicken (n = 50)			*Ternasco de Aragón (n = 50)*		
	Before	*After*	*Change*	*Before*	*After*	*Change*
BMI (kg/m^2)	23.15 ± 3.57	23.25 ± 3.61	0.08 ± 0.51	23.16 ± 3.56	23.20 ± 3.65	0.04 ± 0.47
Skinfolds (mm)						
Bíceps	7.71 ± 3.26	8.16 ± 3.54	0.44 ± 1.49	7.81 ± 3.95	8-04 ± 3.89	0.22 ± 1.53
Tríceps	14.35 ± 6.06	14.95 ± 6.38	0.60 ± 2.63	14.89 ± 6.89	15.19 ± 6.53	0.30 ± 3.29
Subescapular	12.55 ± 4.47	13.32 ± 5.89	0.78 ± 3.04	13.00 ± 6.25	12.91 ± 5.53	-0.08 ± 3.30
Suprailiac	12.26 ± 6.22	12.90 ± 6.14	0.64 ± 1.95	12.81 ± 6.30	12.77 ± 6.42	-0.03 ± 1.91**
Thigh	20.52 ± 7.47	21.66 ± 7.84	1.01 ± 2.40	20.85 ± 7.41	21.24 ± 7.69	0.75 ± 2.54
Calf	15.33 ± 6.47	15.41 ± 6.37	0.49 ± 3.28	14.89 ± 5.71	15.73 ± 6.57	0.63 ± 2.69
Σ 6 skinfolds	80-10 ± 26.57	85.47 ± 28.93	4.07 ± 6.09	84.24 ± 31.42	84.18 ± 28.77	2,43 ± 7.10
Circunferences (cm)						
Arm	28.00 ± 3.29	28.14 ± 3.25	0.14 ± 0.76	28.05 ± 3.20	27.98 ± 3.17	-0.07 ± 0.75
Bíceps	29.25 ± 3.72	29.34 ± 3.58	0.08 ± 0.80	29.30 ± 3.56	29.18 ± 3.63	-0.11 ± 0.81
Waist	79.29 ± 8.74	79.85 ± 8.82	0.55 ± 3.20	80.26 ± 8.60	79.34 ± 8.67	-0.92 ± 2,85**
Hip	97.49 ± 7.34	97.70 ± 7.16	0,21 ± 1.98	97.57 ± 7.38	97.72 ± 7.40	0.14 ± 2.13
Proximal high	56.88 ± 5.08	56.43 ± 4.83	-0.45 ± 1.76	56.94 ± 5.07	56.72 ± 4.97	-0.22 ± 1.63

*Data presented as mean ± stantard deviation.
**p < 0.05 for changes over time.
BMI: Body mass index.
Σ 6 skinfolds, sum of six skinfolds.

Table IV
*Cardiovascular risk factors: before and arter the two interventions**

	Chicken (n = 50)			*Ternasco de Aragón (n = 50)*		
	Before	*After*	*Change*	*Before*	*After*	*Change*
Total cholesterol (mg/dL)	163.76 ± 29.45	166.92 ± 37.19	2.08 ± 19.26	164.82 ± 33.10	162.55 ± 31.67	0.31 ± 21.77
Triacylglycerols (mg/dL)	72.30 ± 36.40	75.98 ± 52.76	4.23 ± 43.22	77.68 ± 32.54	67.45 ±32.71	-8.85 ± 20.43**
HDL colesterol (mg/dL)	49.52 ± 12.81	49.24 ± 12.24	-0.59 ± 8.89	48.39 ± 13.38	49.06 ± 12.57	1.91 ± 8.31
LDL colesterol (mg/dL)	93.94 ± 26.04	96.14 ± 29.25	1.53 ± 16.91	99.24 ± 27.19	92.71 ± 27.19	-3.93 ± 15.43
CT/HDL	3.50 ± 1.06	3.53 ± 0.94	0.01 ± 0.56	3.65 ± 1.09	3.52 ± 1.11	-0.10 ± 0.60
Systolic BP	119.75 ± 13.80	119.29 ± 14.10	-0.45 ± 8.15	120.19 ± 13.84	119.35 ± 11.48	-0.80 ± 9.59
Diastolic BP	69.25 ± 7.08	70.35 ± 7.12	1.10 ± 7.91	70.39 ± 6.66	70.49 ± 7.81	0.10 ± 8.68
Heart rate	75.16 ± 11.40	76.98 ± 13.28	1.82 ± 11.33	73.28 ± 11.53	74.80 ± 12.15	1.52 ± 11.92
Glucose (mg/dL)	78.44 ± 6.16	79.70 ± 7.36	1.61 ± 5.78	79.84 ± 7.35	79.27 ± 8.80	-0.63 ± 7.19
Insulin (µU/mL)	7.67 ± 3.62	8.38 ± 5.80	0.80 ± 5.52	8.49 ± 3.89	7.06 ± 3.19	-1.23 ± 3.89**

*Data presented as mean ± stantard deviation.
**$p < 0.05$ for changes over time.
HDL: High-density lipoprotein; LDL: Low-density lipoprotein; CT/HDL: Total cholesterol/high-density lipoprotein quotient; Systolic BP: Systolic blood pressure; Diastolic BP: Diastolic blood pressure.

= 0.049) decreased after the lamb consumption. Glucose concentrations also showed a reduction after consuming lamb, but the decrease was not statistically significant (table IV).

Discussion

Young age and adolescence are considered to be critical periods for the onset of obesity and obesity-associated morbidity in later life mainly because of fat depots localization in the abdominal region. A rather reliable anthropometric marker of abdominal obesity is waist circumference which measures visceral and subcutaneous fat in the abdominal region and hence total abdominal fatness. Waist circumference correlates well with intra-abdominal and subcutaneous fat measured by magnetic resonance imaging in young people,[15] is also a central feature of the metabolic and a good tool for the screening of total body fat and the metabolic syndrome.[10,12,16,17,18] Skinfold thickness measures subcutaneous fat at one or more sites to characterize total adiposity. The main cardiovascular risk indicators related with adipose tissue distribution are triglycerides, high-density lipoprotein cholesterol, insulin and blood pressure.[19]

In this study, the effect of the consumption of diets rich in different sources of protein in cardiovascular risk indicators was measured. Consumption of lamb or chicken as part of a nutritionally balanced diet, did not have an effect on BMI, plasma total cholesterol, LDL-cholesterol, HDL-cholesterol and the sum of their 6 skinfold thicknesses in this sample of healthy young people. On the other hand, tryacilglycerol and insulin concentrations were reduced.

Our results support data from previously published studies[3,4,5] suggesting that red meat (ruminant meat) and chicken could be interchangeable in a healthy and balanced diet as well as in a low-fat diet of hypercholesterolemic men and obese women.

The observed effect might be attributed partly to the presence of unsaturated fats in lamb, such as oleic acid and conjugated linoleic acid, suggested to promote cardiovascular health[3]. Ruminant meat is a natural source of conjugated linoleic acid (CLA); lamb is the richest meat source of CLA.[20] Small amounts of CLA (0.5% of the diet) have shown to alter the expression of genes and impact conditions such as carcinogenesis, obesity, diabetes and atherosclerosis in experimental animals; in addition, human supplementation studies suggested reduction of body weight and body fat following CLA supplementation for a short period of time. Therefore, CLA may be a healthy dietary component related to human health in the areas of cancer, obesity, diabetes and cardiovascular disease.[21]

CLA and fatty acid composition of commercial lambs from different production systems (including Spain) were studied, as well as the influence of different cooking methods on CLA, fat content and fatty acid composition of edible lambs. Muscle of light lambs reared intensively was reported to have a higher concentration of unsaturated fatty acids compared to saturated acids (SFAs). Additionally omega-3 fatty acid concentrations were less affected by the cooking process compared to concentrations of omega-6 fatty acids.[22,23] The proportion of fatty acids is affected by trimming the fat: lean meat is higher in polyunsaturated fatty acids (PUFA) and lower in SFAs than untrimmed meat. Lean meat is also a source of polyunsaturated fats, including omega-3 fatty acids, and pasture feeding contributes significantly to omega-3 fatty acid intakes in the diet.[20,24] In contrast, meat from grain-fed animals does not provide omega-3 fatty acids but it is rich in omega-6 fatty acids (linoleic acid).[25] In relation to the lipid composition in young and light lambs like *Ternasco de Aragón,* there are differences in the quantity and quality of the meat compared to other lambs, which are older and heavier or grass fed.[26] Due to the age of slaughtering and feeding, *Ternasco de Aragón* has a higher unsaturated lipid profile, less fat percentage and less total cholesterol. Meat consumed from other types of lamb (from Anglo-Saxon bibliography) often comes from older and pasture-fed lambs. Pasture increases omega-3 fatty acids at intramuscular level; it produces a beneficial reduction of the n-6/n-3 ratio below the optimum of 4.[26] But this is associated to older lambs, less energy density of the lamb diet, more general greased meat and more saturated fat than younger lambs like *Ternasco de Aragón,*[26] especially if they are previously weaned.[27]

Conclusion

The results of our study suggest that regular consumption of light lamb *(Ternasco de Aragón)* can form part of a healthy, varied and well-balanced diet. This is mainly due to observed changes in body composition and in cardiovascular disease risk indicators following a *lamb*-based-diet. This study provides further evidence to support modification of established recommendations for health professionals, regarding the role of different types of meat to be consumed.

Acknowledgements

The authors wish to thank all participants for their collaboration recruited in three following centers: *Residencia Juvenil "Luis Buñuel", Instituto Aragonés de la Juventud, Departamento de Servicios Sociales y Familia* of *Teruel; Residencia Juvenil "Baltasar Gracián", Instituto Aragonés de la Juventud, Departamento de Servicios Sociales y Familia of Zaragoza;* and *Residencia Internado "Santa Emerenciana", Departamento de Educación* of *Teruel.*

We sincerely thank the *Servicio de Análisis Clínicos, Laboratorio de Bioquímica* of *the Hospital General "Obispo Polanco"* of Teruel for their assistance with the blood analysis, and the *Escuela Superior de Hostelería de Aragón* of Teruel and the *Instituto de Técnica y Tecnología Agroalimentaria (INTA)* of Teruel for their collaboration, preparing the used recipes and the meat chemical analysis, respectively.

We gratefully acknowledge our colleagues of the GENUD Group, who helped to assess all measurements and questionnaires.

Funding

The study took place with the financial support of the INIA (*Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria*), INIA PET 2007-007-C08-03, and it was co-financed by the *Fondo Europeo de Desarrollo Regional* (FEDER).

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