

Postprandial Lipemia: Influence of Aging

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Objective

To investigate the behavior of postprandial lipemia assessed by means of repeated measurements of triglyceride levels in healthy individuals aged from 20 to 50 years, divided into the following 3 age groups: GI - from 20 to 30 years; GII - from 31 to 40 years; and GIII - from 41 to 50 years.

Methods

Triglyceride levels were measured in 3 conditions: after a 12-hour fast, and 2 and 6 hours after a standard meal containing 40 g of fat.

Results

The repeated-measures analysis of triglyceride levels showed a distinct behavior of the age groups throughout the 6 hours. The younger participants (GI) had a reduction in the triglyceride levels in the sixth hour; the elderly (GIII) had increasing values in the sixth hour; and those in the intermediate age group (GII) maintained their triglyceride levels, when comparing the second and sixth hours of blood collection. The differences in behavior were significant ($P=0.01$).

Conclusion

In a healthy adult population sample, aging influences the postprandial lipemia behavior.

Key words

postprandial lipemia, aging, lipid metabolism

The term “postprandial lipemia” refers to a series of metabolic events related to the increase in the concentration of triglyceride-rich lipoproteins (LP) – chylomicrons (Qm) and their remnants, and very-low-density lipoprotein (VLDL) and its remnants – that occurs after the ingestion of fat.

After a fatty meal, the peak of chylomicrons is usually reached between 3 and 6 hours, and, after a period of 12 hours those particles are no longer detected in healthy individuals¹.

Some studies^{2,3} have reported that triglycerides are not components of the atherosclerotic plaques, but triglyceride-rich lipoproteins are believed to participate directly or indirectly, or both, in atherosclerosis, due to the link between their metabolism and that of the low-density (LDL) and high-density (HDL) lipoproteins, which are known to be related to the atherosclerotic process.

The direct participation of intact chylomicrons in the process has been ruled out because of their large diameter, but the participation of their remnants, as first suggested by Zilversmit⁴, has gained the support of experimental studies^{5,6}, which have evidenced the build up of chylomicrons remnants in the aorta of rabbits. The indirect participation could occur through the accumulation of chylomicrons and consequent excess of VLDL, IDL (intermediate-density lipoprotein) and LDL. In the postprandial period, the chylomicrons and VLDL compete by the lipoprotein lipase (LLP), the enzyme that hydrolyzes triglycerides. Some studies^{7,8} have reported that chylomicrons are the preferred substrate of LLP, which causes VLDL to build up in the postprandial period.

The association of aging and atherosclerosis is also relevant, the mechanism of the latter could be partly explained by the influence of age on postprandial lipemia.

The objective of this study was to assess the behavior of postprandial lipemia in adult individuals. Usual conditions, such as food composition and the interval between meals, were imitated in a clinically healthy and relatively young population.

Methods

Sixty-four healthy individuals (26 men and 38 women) were selected for this study. Their ages ranged from 20 to 50 years, and they were divided into the following 3 age groups: GI, from 20 to 30 years ($n=14$); GII, from 31 to 40 years ($n=25$); and GIII, from 41 to 50 years ($n=25$).

The exclusion criteria were as follows: impaired thyroid function; diabetes mellitus; alcoholism; liver disease; heart disease; renal failure; autoimmune and inflammatory diseases, or any other disease capable of interfering with the absorption and metabolism of lipoproteins; use, in the 90 preceding days, of a medication that could alter the transport and metabolism of lipoproteins, including

contraceptive drugs; blood pressure=140/90 mmHg; body mass index (BMI)=40 kg/m²; TC=300 mg/dL; TG=300 mg/dL; and aerobic physical activity for a period longer than 40 minutes, more than once a week.

The participants were instructed to fast from 8 PM on the day preceding the experiment, drinking only water after that time. On the next day, all participants had to be at the laboratory around 7:30 AM and remain at rest without ingesting any type of food, except the standard meal and water. The meal was ingested in up to 15 minutes and comprised sandwich loaf (2 slices), Edam-like cheese (40 g), fatty ham (40 g), mayonnaise (15 g), and chocolate milk (400 mL). The meal had 78 mg of cholesterol and 882 kcal distributed as follows: proteins, 35 g (16%); fat, 40 g (42%), 50% in the form of saturated fat; and carbohydrates, 89 g (42%).

After anamnesis, the participants underwent a complete physical examination. The BMI and body surface area (BS) were calculated. The fat distribution was determined by the ratio between the abdominal circumference (measured at the level of the umbilicus) and the hip circumference (taken at the level of the greater trochanter), the so-called abdomen-hip ratio (AHR).

Three blood samples were collected from each participant as follows: after a 12-hour fast, and 2 and 6 hours after the standard meal. The serum triglyceride levels were measured in the 3 samples and were denominated TG(t1), TG(t2), TG(t3). In the sample of the fasting period, the following parameters were also assessed: TC; HDL-cholesterol; glycemia; TSH; and isotyping of apolipoprotein E.

The serum TG and TC levels were measured by use of the enzymatic colorimetric method in the automate Cobas-Integra 700 device (Roche Diagnostics, Somerville, NJ, USA). The HDL-C level was obtained by the same method used to measure TC, after precipitation of the lipoproteins containing apolipoprotein B with a solution of magnesium chloride and phosphotungstic acid. Glycemia was determined through the enzymatic method with hexokinase. The serum levels of TSH were quantitatively measured through immunometric assay with the Immulite 2000 analyzer.

Genotyping of apo E was performed according to the method described by Hixson and Vernier⁹. The gene DNA was amplified by use of the polymerase chain reaction (PCR) in the GeneAmp PCR System 2400 thermocycler (Perkin Elmer Cetus).

The experiment was repeated in 6 randomly chosen participants, following the same procedures, and previous data of clinical and physical examinations were compared.

The data were analyzed by use of descriptive measures, such as frequency for categorical variables (gender, familial antecedent for coronary artery disease, smoking, apo E phenotypes), and mean and standard deviation (SD) for continuous variables (age, BMI, AHR, and fat consumption proportional to BMI).

Comparison between the age groups in regard to the continuous variables was performed with analysis of variance (ANOVA). Occasional differences were identified by use of the multiple comparisons test. In regard to the categorical variables, the groups were compared by using the chi-square test or Fisher exact test. The behavior of the triglycerides was studied through repeated-measures analysis of variance of the triglyceride levels in the age groups. Pearson correlation test was used with a 95% confidence interval to compare the triglyceride levels obtained in 2 opportunities in which the protocol was used in 6 participants. The significance level of 0.05 ($\alpha=5\%$) was adopted.

Results

No significant differences in the age groups were observed in regard to the numerical variables (BMI, BS, AHR, and fat consumption proportional to BMI) (tab. I). No significant differences were observed in the age groups in regard to the categorical variables sex, smoking, and familiar antecedent (tab. II).

No significant differences were observed in the distribution of apo E phenotypes in the age groups ($P=0.12$). The most frequent phenotypes were E3/E3 ($n=40$; 62.5% of the sample); E3/E4 ($n=13$; 20.3%); E2/E3 ($n=8$; 12.5%); and E4/E4 ($n=3$; 4.7%).

The analysis of variance (ANOVA) showed significant differences

Table I - Clinical characteristics of the sample and age groups. Comparison of the means and standard deviations by use of analysis of variance

Numerical variables	Total sample n=64	GI 20 to 30 years n=14	GII 31 to 40 years n=25	GIII 41 to 50 years n=25	P value
BMI (kg/m ²)	26.21±4.78	24.77±5.57	26.1±4.73	27.1±4.33	0.34
AHR	0.88±0.07	0.86±0.05	0.88±0.07	0.90±0.08	0.14
Consumption/BMI (g/kg/m ²)	1.58±0.29	1.69±0.36	1.58±0.27	1.51±0.24	0.17

BMI = body mass index; AHR = relation between the abdominal circumference and that of the hip; consumption/BMI = relation between the amount of fat consumed (40 g) and body mass index.

Table II - Distribution of the frequency of the clinical characteristics (gender, smoking, and familial antecedent of CAD) in the sample and age groups

Categorical variables	Total sample n=64	GI 20 to 30 years n=14	GII 31 to 40 years n=25	GIII 41 to 50 years n=25	P value
Men	26 (40.6%)	5 (35.7%)	11 (44%)	10 (40%)	0.95
Women	38 (59.3%)	9 (64.2%)	14 (56%)	15 (60%)	
Smokers	10 (15.6%)	1 (7.1%)	4 (16%)	5 (20%)	0.62
Nonsmokers	54 (84.3%)	13 (92.9%)	21 (84%)	20 (80%)	
Antecedent (+)	8 (12.5%)	1 (7.1%)	6 (24%)	1 (4%)	0.12
Antecedent (-)	56 (87.5%)	13 (92.9%)	19 (76%)	24 (96%)	

Antecedent (+) = familial antecedent for coronary artery disease; Antecedent (-) = no familial antecedent for coronary artery disease.



in the mean values of TC, TG, and glycemia in the age groups (tab. III). The GIII participants (41 to 50 years) had greater mean values of TC, TG, and glycemia than those of the younger participants (GII and GI).

The repeated-measures analysis of variance of the triglycerides showed a group vs time interaction, ie, the groups had distinct triglyceride behaviors in the t1, t2, and t3 times ($P=0.01$) (fig. 1). Analysis of each age group throughout time showed significant differences in the means in almost all groups, except for GII, in which the mean value of TG(t2) did not significantly differ from that of TG(t3) ($P=0.87$), indicating maintenance of the TG values at that time. In GI, a significant drop was observed in the mean value of TG(t3) as compared with that in TG(t2) ($P=0.03$). In GIII, the mean value of TG(t3) was significantly greater than that of TG(t2) ($P=0.007$), indicating increasing values of TG at that time (tab. IV).

Repetition of the experiment provided 92% correlation values of triglycerides at time 1 (fasting period sample), 93% at time 2 (2 hours after the standard meal), and 92% at time 3 (6 hours after the standard meal).

Discussion

The results obtained in the assessment of triglycerides showed that the behavior of postprandial lipemia was different in the different age groups. The youngest group, GI, had the fastest drop in triglyceridemia; GII had an intermediate drop; and GIII had an elevation in triglyceridemia during the 6 hours studied.

The differences found could be attributed to the gastric emptying time or intestinal absorption, or both. Some studies have shown that the gastric emptying of liquids and solids decreases with age¹⁰, but intestinal motility is not altered with age¹¹. Pancreatic secretion slightly decreases with age¹². However, Arora et al¹³ studying 114 healthy individuals have reported that fecal excretion, and, consequently, fat absorption changes slightly with age, suggesting that the decrease in pancreatic secretion is not enough to hinder the normal digestive process.

One could imagine that because older individuals have a longer gastric emptying time, the absorption of fat would be slowed, justifying a late elevation in triglyceridemia. Krasinski et al¹⁴, studying the postprandial lipemia in 86 healthy men and women (age, 19 to 76 years) with oral and intravenous vitamin A, have ruled out the possibility that the differences in the lipemia behavior observed in individuals under and above the age of 50 years were related to changes in the digestive absorptive processes, because the lipemia behavior was similar both in the intravenous infusion and in the oral ingestion of vitamin A. The retinyl ester, a vitamin A metabolite that incorporates to the chylomicron, and, therefore, follows the metabolic path of that element, was elevated in the group above 50 years with both administration routes of vitamin A. Therefore,

the delay in the clearance of postprandial lipemia was greater in older individuals independently of the digestive/absorptive factor. Krasinski et al¹⁴ have reported that the delay in the clearance of retinyl ester in older individuals was caused by the slow down in the chylomicron clearance, due to, among other factors, the decrease in the lipoprotein lipase (LLP) activity, which occurs as age increases. The decrease in the LLP activity that occurs as age increases has also been reported by Huttunen et al¹⁵ in tests with heparin stimulation, and by Weintraub et al¹⁶ using vitamin A (oral) in 27 healthy individuals from 19 to 72 years.

Therefore, one may assume that the decrease in the LLP activity may justify the significant difference in the behavior of postprandial lipemia in the age groups studied.

The fasting TG and TC levels were significantly greater in GIII (41 to 50 years) than those in the remaining age groups, $P=0.02$ and $P<0.01$, respectively. Nestel¹⁷ was one of the first to correlate the elevated fasting triglyceride levels with a slow chylomicron clearance rate, indicating that they could be predictors of the retarded postprandial lipemia. The TC levels are known to increase with age, possibly due to a decrease in the number of B/E receptors¹⁸. Fasting glycemia was also significantly more elevated in GIII than that in the other groups ($P<0.01$).

The assessment of these variables could evidence interrelated metabolic mechanisms, insulin resistance being the link between them¹⁹. The inability of adipose cells to store triglycerides caused by insulin resistance could be the initial step of this metabolic circuit. The greater release of free fatty acids and their reduced uptake by adipose cells could cause an inflow of fatty acids from the adipose tissue to the liver, leading to gluconeogenesis and an increase in the production of VLDL, and, therefore, of LDL. Insulin resistance could also cause oxidation of the fatty acids in the

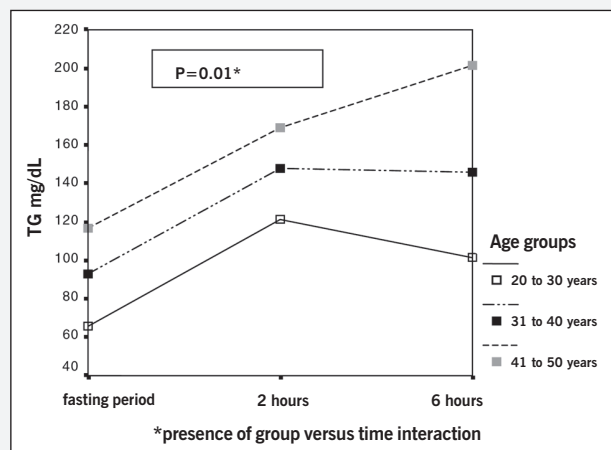


Fig. 1 - Behavior of triglyceride levels after ingestion of a test diet in the different age groups by use of repeated-measures analysis of variance.

Table III - Laboratory characteristics of the sample and age groups. Comparison of the means and standard deviations by use of analysis of variance

Variable (mg/dL)	Total sample n=64	GI 20 to 30 years n=14	GII 31 to 40 years n=25	GIII 41 to 50 years n=25	P value
TC	190.22±45.4	157.9±10.6	185.3±7.96	208.1±7.9	<0.01*
TG	96.13±56.9	65±5.3	92.6±10.9	116.6±13.1	0.02 *
HDL- C	48.78±11.4	46.5±3.1	49.8±2.3	48.9±2.3	0.6
Glucose	91.97±10.5	86.4±2.6	90.2±1.9	96.8±1.9	<0.01*

* $P=0.05$.

Table IV - Triglyceride levels (mg/dL) during the fasting period and after the test diet in the different age groups. Comparison between the groups at each time by use of analysis of variance

Age groups	TG (t1)	TG(t2)	TG(t3)
GI: 20 – 30 years	65.71±5.39	121.29±13.74	101.57±11.97
GII: 31 – 40 years	92.68±10.98	147.76±16	145.88±20.32
GIII: 41 – 50 years	116.60±13.10	168.96±16.61	201.7±20.91
P value	p=0.02 *	p=0.17	p<0.01 *

* P=0.05. TG(t1) = mean TG level during the fasting period; TG(t2) = mean TG level 2 hours after ingesting the test diet; TG(t3) = mean TG level 6 hours after ingesting the test diet.

muscle tissue, leading to a greater accumulation of glucose, and, consequently, to a greater stimulus to the production of insulin, perpetuating that cycle^{20, 21}.

Our results were not influenced by physical activity, because it was considered an exclusion criterion when selecting the sample. However, it is worth emphasizing that the regular practice of physical activity may delay the appearance of such metabolic modifications. Cohen et al²² have assessed the influence of physical exercise in the postprandial lipemia behavior of athletes and individuals with a sedentary life style, and reported that, in athletes,

the clearance of postprandial lipemia is faster than that in individuals with a sedentary life style. Ericsson et al²³, studying the clearance of lipid emulsions, reported that the fat clearance rate was faster in athletes.

The study of the apo E phenotypes in this sample have not influenced the results obtained, although Weintraub et al¹⁶ have reported a longer postprandial lipemia in individuals with the E2 allele, E2/E2 and E3/E2 phenotypes.

In this study, the differentiated behavior of the postprandial lipemia in narrow and early age group intervals (20 to 30 years; 31 to 40 years; 41 to 50 years) is worth noting. The metabolic alterations were caused by the standardized meal with a relatively low fat content (40 g, 50% being saturated fat) if compared with studies assessing postprandial lipemia by using a standardized meal with a high fat content (70 g). Such findings stress the need for adopting preventive measures in early age groups, with fat consumption restricted to a maximum of 30% of the total caloric value, and saturated fat consumption restricted to 7% of that value, as recommended by the current guidelines for prevention of cardiovascular diseases^{24,25}.

In conclusion, aging has a significant effect on postprandial lipemia in healthy, young individuals.

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