

# Effects of age, gender and physical activity on plasma lipid profile

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## Summary

*Study aim:* To assess the effects of gender, age and engagement in physical activities of elderly subjects on their plasma lipid profiles.

*Material and methods:* Four groups of subjects,  $n = 11$  each, participated in the study: young men (YM) and women (YW), aged 25 – 32 years, and sedentary, elderly men (EM) and women (EW), aged 58 – 66 years; additionally, a group of 7 women (AW), aged 60 – 65 years, who trained twice weekly (45-min sessions) for 8 months, was studied. The following concentrations of lipids in plasma were recorded: triacylglycerols (TG), total cholesterol (TC) and its fractions: HDLC and LDLC (computed), as well as the TC/HDLC ratio.

*Results:* Lipid profiles were, generally, less favourable in elderly than in younger subjects, high HDLC values noted in active, elderly women being an exception. In elderly subjects, men's profiles were closer to those of younger subjects than in elderly women and differed significantly ( $p < 0.001$ ) lower for TC and LDLC compared with EW group. Triacylglycerols were within normal limits in all groups except EW; LDLC values were mostly abnormally high, the percentages of subjects having normal values ranging from 0 (YM and EW) to 27% (YW).

*Conclusions:* The age-dependent worsening of lipid profiles increased the risk of cardiovascular diseases in sedentary elderly subjects. On the other hand, the beneficial effects of motor activities on lipid profile observed in elderly women evidence the indispensability recommending of physical exercises to the elderly.

**Key words:** Men – Women – Lipid profile – Age – Physical activity

## Introduction

Circulating lipoproteins contain triacylglycerols, cholesterol and its esters, and phospholipids, in addition to specific proteins. The high-density lipoproteins (HDL) carry cholesterol from peripheral cells to the liver, while low-density lipoproteins (LDL) carry cholesterol in the reverse direction. Due to those functions, increased levels of LDL augment the risk of cardiovascular diseases, while HDL is a vessel-protective agent preventing the formation of atherosclerotic changes [16]. Moreover, although an increased risk of cardiovascular diseases is associated with augmented levels of LDL and triacylglycerols, the latter induce that risk also independently of LDL [2].

Cardiovascular diseases, like ischaemic heart disease, infarction or cerebral stroke, affect mainly elderly and middle-aged subjects but the onset of those diseases takes place in the childhood [3,27]; increased LDL and decreased HDL are associated with arterial hypertension which precedes those diseases [23]. The prevalence of atherosclerosis was reported to be closely correlated with

engagement in physical exercises which also significantly reduce plasma lipids, especially total cholesterol and LDL, and increase HDL [7,9]. It has been emphasised that a healthy lifestyle, i.e. restricted smoking and alcoholic drinks, well balanced diet and practicing motor activities, are prerequisites for a favourable plasma lipid profile and for preventing cardiovascular diseases [14].

A low level of LDL is known to reduce atherosclerotic changes and the prevalence of ischaemic heart disease, and a decreased risk of that latter disease resulting from the protective role of estrogens in pre-menopausal women was associated with significantly lower LDL and triacylglycerols, and higher HDL compared with men [12]. Those trends are, however, often reversed in post-menopausal women [4].

Concentrations of total cholesterol and its fractions in blood are known to depend on practicing motor activities [26]; HDL levels were reported to be significantly higher in athletes than in sedentary subjects [17,18]. However, no detailed reports on the intensity, volume and frequency of exercises necessary to induce positive

changes in lipid profile, especially in elderly subjects. Thus, the aim of this study was to assess the effects of gender, age and engagement in physical activities of elderly subjects on their plasma lipid profiles.

## Material and Methods

**Subjects:** Four groups of subjects,  $n = 11$  each, participated in the study: young men (YM) and women (YW), aged 25 – 32 years, and sedentary, elderly men (EM) and women (EW), aged 58 – 66 years; additionally, a group of 7 women (AW), aged 60 – 65 years, who trained twice weekly for 8 months, was studied. Their training consisted of 45-min sessions which included gymnastics, dancing and flexibility exercises. None of the subjects smoked. All subjects submitted their written consents to participate in the study after having been familiarised with its scope and protocol. The study was approved by the local Ethics Committee.

**Measurements:** Body height, body mass and BMI were recorded by using standard anthropometer and medical scales, the accuracies amounting to 0.1 cm and 0.1 kg, respectively. Body fat content was assessed from skinfold thickness measurements (biceps, triceps, hip and subscapular; accuracy 0.1 cm) according to Durnin *et al.* [8]. Blood samples were withdrawn from the ante-cubital vein in the pre-prandial state in the morning into heparinised tubes and centrifuged. The collected plasma was stored frozen at  $-70^{\circ}\text{C}$  until assayed. The following concentrations of lipids in plasma were recorded: triacyl-

glycerols (TG), total cholesterol (TC) and its HDL fraction (HDL) using commercial assay kits (Alpha Diagnostics, Poland). The LDL fraction (LDL) was computed using Friedewald's equation [11]. In addition, the TC/HDL ratio was computed and the frequencies of normal values of those components were recorded in all groups of subjects, normal values being taken from the 3<sup>rd</sup> Report of the Team of Experts of the National Cholesterol Education Program, USA [29].

**Data analysis:** Shapiro-Wilk's test was used to assess data normality. Student's *t*-test for independent data was used to assess the between-group differences for normally distributed variables and the Mann-Whitney's *U*-test for variables deviating from normal distribution. Body fat content and BMI data for sedentary groups were subjected to two-way ANOVA. The log-linear form of the chi-square function was used to assess the frequencies. The level of  $p \leq 0.05$  was considered significant.

## Results

The results are presented in Tables 1 – 3. Regarding the most meaningful indices, i.e. body fat content and BMI, both age and gender showed significant ( $p < 0.01$ ) differences in body fat content while for BMI a significant difference was found only for age ( $p < 0.05$ ; by ANOVA). Active, elderly women (Group AW) had significantly lower body fat content ( $p < 0.01$ ) and BMI ( $p < 0.05$ ) than their sedentary mates (Group EW; cf. Table 1).

**Table 1.** Mean values ( $\pm$ SD) of somatic data of subjects

| Variable               | Group<br>n=11 | YM<br>n = 11    | YW<br>n = 11      | EM<br>n = 11      | EW<br>n = 11           | AW<br>n = 7      |
|------------------------|---------------|-----------------|-------------------|-------------------|------------------------|------------------|
| Age (years)            |               | $28.5 \pm 4.1$  | $32.0 \pm 3.9$    | $66.2 \pm 5.1$    | $67.5 \pm 4.25$        | $68.0 \pm 6.5$   |
| Body height (cm)       |               | $177.9 \pm 5.9$ | $165.6 \pm 4.8^A$ | $172.4 \pm 6.2^A$ | $159.0 \pm 7.14^{B,C}$ | $156.9 \pm 4.3$  |
| Body mass (kg)         |               | $78.5 \pm 11.5$ | $60.3 \pm 4.8^A$  | $78.3 \pm 10.9$   | $72.4 \pm 10.0^B$      | $63.0 \pm 6.4^B$ |
| BMI *                  |               | $22.9 \pm 7.0$  | $22.0 \pm 1.7$    | $26.6 \pm 1.6$    | $28.6 \pm 2.8$         | $25.6 \pm 2.1^B$ |
| Body fat content (%)** |               | $17.6 \pm 4.9$  | $29.9 \pm 2.4$    | $28.5 \pm 0.6$    | $43.9 \pm 5.2$         | $34.3 \pm 5.7^B$ |

Legend: Sedentary subjects: M – Men; W – Women; Y – Young (25 – 32 years of age); E – Elderly (58 – 66 years of age); AW – Physically active women aged 60 – 65 years; Significantly ( $p < 0.01$ ) different from: <sup>A</sup> Group YM, <sup>B</sup> Group EW, <sup>C</sup> Group EM; \* Significant ( $p < 0.05$ ) difference between older and younger subjects; \*\* Significant ( $p < 0.01$ ) between-age and between-gender differences

Lipid profiles of young men and women (Groups YM and YW) were practically identical (Table 2). The profiles of sedentary elderly men and women were nearly parallel to one another, the profile of men (EM) being closer to that of younger subjects than that of women and differed significantly from young men (YM) only in TG ( $p < 0.01$ ). The profile of elderly women (EW) differed significantly ( $p < 0.001$ ) from that of young women

(YW) in all variables except HDL and from their male mates in TC and LDL. The profile of active elderly women (AW) was closest to that of young women, the TC and HDL being significantly ( $p < 0.05$ ) higher. That latter value was significantly ( $p < 0.05$ ) highest compared with all other groups. As to the TC/HDL ratio, significantly ( $p < 0.001$ ) highest values were noted in sedentary elderly subjects (Groups EM and EW).

**Table 2.** Mean values ( $\pm$ SD) of lipid profile components

| Variable      | Group<br>YM<br>n = 11        | YW<br>n = 11       | EM<br>n = 11       | EW<br>n = 11    | AW<br>n = 7                   |
|---------------|------------------------------|--------------------|--------------------|-----------------|-------------------------------|
| TG (mmol/l)   | 0.78 $\pm$ 0.14 <sup>A</sup> | 0.69 $\pm$ 0.17*** | 1.35 $\pm$ 0.55    | 1.59 $\pm$ 0.65 | 0.72 $\pm$ 0.17**             |
| TC (mmol/l)   | 4.88 $\pm$ 0.77              | 4.87 $\pm$ 0.59*** | 5.25 $\pm$ 0.77*** | 6.56 $\pm$ 0.83 | 6.04 $\pm$ 1.16* <sup>B</sup> |
| HDLC (mmol/l) | 1.55 $\pm$ 0.72              | 1.53 $\pm$ 0.36    | 1.29 $\pm$ 0.21    | 1.52 $\pm$ 0.32 | 1.90 $\pm$ 0.24* <sup>B</sup> |
| LDLC (mmol/l) | 2.98 $\pm$ 0.30              | 3.07 $\pm$ 0.62*** | 3.34 $\pm$ 0.63*** | 4.31 $\pm$ 0.80 | 3.81 $\pm$ 1.18               |
| TC/HDLC       | 3.50 $\pm$ 0.97              | 3.39 $\pm$ 1.03*** | 4.20 $\pm$ 0.97    | 4.46 $\pm$ 1.12 | 3.25 $\pm$ 0.88***            |

Legend: TG – Triacylglycerols; TC – Total cholesterol; HDLC – HDL fraction of cholesterol; LDLC – LDL fraction of cholesterol; Significantly different from Group EW: \*  $p < 0.05$ ; \*\*\*  $p < 0.001$ ; <sup>A</sup> Significantly ( $p < 0.01$ ) different from Group EM; <sup>B</sup> significantly different from Group YW; For other explanations see Table 1

**Table 3.** Frequencies of normal values of lipid constituents recorded in studied subjects

| Group    | YM<br>n = 11 |     | YW<br>n = 11 |     | EM<br>n = 11 |     | EW<br>n = 11 |     | AW<br>n = 7 |     |
|----------|--------------|-----|--------------|-----|--------------|-----|--------------|-----|-------------|-----|
| Variable | n            | %   | n            | %   | n            | %   | n            | %   | n           | %   |
| TG       | 11           | 100 | 11           | 100 | 10           | 91  | 7            | 64* | 7           | 100 |
| TC       | 6            | 55  | 8            | 73* | 4            | 36  | 0            | 0*  | 1           | 14  |
| HDLC     | 4            | 36  | 7            | 64  | 1            | 9*  | 6            | 55  | 6           | 86* |
| LDLC     | 0            | 0°  | 3            | 27° | 2            | 18° | 0            | 0°  | 1           | 14  |

\* Significantly ( $p < 0.01$ ) different from all other groups; ° Significantly ( $p < 0.05$ ) different from Group YW; For other explanations see Tables 1 and 2

The reference (normal) values (mmol/l): TG – up to 1.7, TC – up to 5.2, HDLC – above 1.5, LDLC – up to 2.6 [29]

Regarding the frequencies of normal values of studied variables recorded in all groups (Table 3), the TG values were within normal limits in all groups except EW ( $p < 0.05$ ). Only 37% of TC values were within normal limits in all groups combined, 47% of HDLC and as few as 12% of LDLC values. Abnormally high total cholesterol predominated in elderly subjects.

## Discussion

The here presented concentrations of triacylglycerols, and cholesterol and its fractions, are in agreement with those of other authors. Ardern *et al.* [1] found no gender-related differences in TG, TC, HDLC and LDLC concentrations and in the TC/LDLC ratio in subjects aged about 35 years. Also Habib *et al.* [13] found no gender-related differences in TC and LDLC in subjects aged about 50 years but women had lower concentrations of TG and higher of HDLC than men. Women aged 18 – 50 years had lower TG and LDLC, and higher HDLC concentrations than men [12]. In women aged 25 years, HDLC levels were higher than in men, although TG, TC and LDLC concentrations were alike [15]. On the other

hand, HDLC levels in the post-menopausal women were reported to decrease due to reduced oestradiol secretion [28]. In this study, no such age-related differences were found in women but the frequency of normal HDLC values in women was significantly higher than in men. According to Collins [5], the post-menopausal period is characterised by increased concentrations of TG and LDLC and decreased HDLC compared with the premenopausal ones. That tallies with our data except HDLC, which was not significantly decreased.

In the study of De Nino *et al.* [6] on 178 women, lower TC values were found in young (20 – 35 years of age) than in the elderly (61 – 78 years of age) ones. The authors suggested that the age-related changes in the lipid profile were due to an increasing content of visceral fat. Although visceral fat was not specifically assessed in this study, the total body fat content was significantly ( $p < 0.01$ ) higher in elderly subjects compared with their younger mates. Similar findings were reported by e.g. Essig *et al.* [10] who found body fat content, TG, TC and LDLC to increase in men and women with age (61 – 70 vs. 21 – 30 years of age).

Regarding the gender-related differences, the concentrations of lipids in plasma of both younger groups (YM and YW) were alike but normal values of TC and LDLC were significantly less frequent in men than in women. In elderly subjects the situation was reversed, only the frequency of normal values of HDLC was in men lower than in women.

Elderly women engaged in regular motor activities were markedly superior to their sedentary mates in all components of lipid profile and body fat content and had highest concentration of HDLC among all studied groups. The effect of exercise could have been mediated by lower body fat content as TC and LDLC increased and HDLC decreased with increasing BMI, thus, indirectly, with body fat content [24]. That latter depends on genetic factors but the environmental ones are indispensable for the obesity to develop [21].

Sedentary lifestyle increases the risk of cardiovascular diseases; when the time spent on driving and watching TV exceeded 23 h/week that risk increased by 37% compared with those who spent on those activities less than 11 h/week [30]. It would be interesting to know what kinds or forms of exercise decrease that risk but such data are lacking. A minimum of exercising 2 h weekly was shown necessary to increase the level of HDLC, the frequency or intensity of exercises having no effect on lipid profile [19]. On the other hand, exercising frequency was shown to affect the lipid profile more than exercise volume or intensity, although that latter was also of importance; nevertheless, elderly subjects ought to exercise at low or moderate intensity in order to avoid possible injuries, heart attack, etc. [22]. Kraus *et al.* [20] studied 159 subjects aged 40 – 65 years and found that a high exercise volume was effective in improving lipid profile; the changes were more pronounced in those whose jogging distance amounted to 17 – 18 miles/week compared with those jogging 11 miles/week. A decreased TC/HDLC ratio was noted only in those who practiced running, not less than 150 min/week [25]. On the other hand, no significant changes in lipid profile was found in women aged over 60 years, who participated in controlled exercises for a year, despite a decrease in the TC/HDLC ratio [31]. It should be noted that in this study active, elderly women spent 90 min/week on exercising which was associated with decreases in TG and TC/HDLC ratio, and increased HDLC compared with their sedentary mates.

Summing up, sedentary elderly subjects, compared with their younger mates, exhibited a marked worsening of the plasma lipid profile which was indicative of an augmented risk of cardiovascular diseases. Gender-related differences in mean values of the studied lipids and lipoproteins were noted only in elderly subjects but values within normal ranges (except TG) were significantly more frequent in young women than in men. Lipid profile in elderly, physically active women was significantly better than in their sedentary mates, especially regarding the HDLC fraction. Thus, in order to reduce the risk of cardiovascular diseases, elderly subjects ought to be strongly advised to engage in motor activities.

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