Comparison of plasma lipids changes after middle-distance running in euglycemic and diabetic subjects

Giuseppe Lippi[1], Cantor Tarperi[2], Gian Luca Salvagno[1], Marco Benati[1], Elisa Danese[1], Martina Montagnana[1], Paolo Moghetti[3], Federico Schena[2]

[1]Section of Clinical Biochemistry, [2]School of Sport and Exercise Sciences, Department of Neurological, Biomedical and Movement Sciences, University of Verona, Verona, Italy; [3]Section of Endocrinology, Diabetes and Metabolism, Department of Medicine, University of Verona, Verona, Italy

Contributions: (I) Conception and design: G Lippi, F Schena, P Moghetti; (II) Administrative support: GL Salvagno, C Tarperi; (III) Provision of study materials or patients: C Tarperi, GL Salvagno; (IV) Collection and assembly of data: C Tarperi, GL Salvagno, M Benati, E Danese, M Montagnana; (V) Data analysis and interpretation: G Lippi; (VI) Manuscript writing: G Lippi; (VII) Final approval of manuscript: All authors.

Correspondence to: Prof. Giuseppe Lippi. Section of Clinical Biochemistry, University Hospital of Verona, Piazzale L.A. Scuro 10, 37134 Verona, Italy. Email: giuseppe.lippi@univr.it.

Background: Although regular performance of aerobic physical exercise is pivotal for preserving or improving health and fitness, scarce information is available on plasma lipids changes after middle-distance running in euglycemic and diabetic subjects.

Methods: Eleven male euglycemic amateur runners (mean age 41±6 years) and 9 male diabetic amateur runners (4 with type 1 and 5 with type 2 diabetes; mean age 55±14 years) participated to a 21.1-km running trial. All subjects belonged to an amateur running team, regularly engaged in amateur running. Blood was collected before the start of the trial and immediately after. The lipid profile, encompassing measurement of total cholesterol, triglycerides, low-density lipoprotein cholesterol (LDL-C) and high-density lipoprotein cholesterol (HDL-C), was assayed with Roche Cobas 6000.

Results: All athletes successfully completed the 21.1-km running trial, with running pace comprised between 9.6–12.8 km/h. In both categories of subjects the values of LDL-C significantly decreased by approximately 6% after the run, whilst HDL-C and triglycerides significantly increased by 6–9% and 30–36%, respectively. The post-run variations of all lipoprotein fractions after the running trial were virtually identical in diabetic and euglycemic subjects.

Conclusions: The results of this study show for the first time that middle-distance running elicits acute favorable changes of lipid profile both in euglycemic and diabetic subjects. This form of endurance exercise shall hence be further fostered for purposes of public health promotion and improvement.

Keywords: Sport; physical exercise; lipids; cholesterol

Introduction

Several lines of evidence now attest that regular performance of aerobic physical exercise is pivotal for preserving or improving health and fitness, and shall hence be part of public health policies. This conclusion is actually supported by a kaleidoscope of metabolic changes that physical activity induces, and which translate into a consistently lower risk of developing cardiovascular, metabolic, musculoskeletal and even malignant disorders (1). Although the vast majority of favorable cardiovascular changes catalyzed by endurance running emerge as long-term (chronic) effects on hemostasis (2) and on the lipid

profile (3,4), the acute impact of endurance exercise on plasma lipids remains controversial in the current scientific literature. Many previous endurance trials have frequently reported inconsistent variations of pro-atherogenic [i.e., low-density lipoprotein-cholesterol (LDL-C) and triglycerides] or anti-atherogenic [high-density lipoprotein-cholesterol (HDL-C)] lipoprotein fractions, with ample inter-study variations (5-7). It is then noteworthy that most currently available studied were based on long-distance running (i.e., marathon or ultra-marathon), whilst data on acute effect of medium-distant running (i.e., between 10–21 km), which is a more common recreational distance typically run by a larger number of recreational athletes, are completely lacking to the best of our knowledge. This seems a notable drawback, since lipid metabolism is directly dependent on running distance, with most changes becoming evident when covering running distances comprised between 10–21 km (8). Even less defined is the acute impact of endurance running on the lipid profile of diabetic patients, since information on this condition is completely lacking compared to euglycemic subjects. Therefore, this study was aimed to investigate the acute changes of plasma lipids after middle-distance running, and compare these variations between euglycemic and diabetic subjects.

Methods

Study design

The present research was part of an event called "Run For Science", which is annually held under the auspices of University of Verona (Verona, Italy). Eleven male euglycemic amateur runners (mean age 41±6 years) and 9 male diabetic amateur runners (4 with type 1 and 5 with type 2 diabetes; mean age 55±14 years) voluntarily engaged in a 21.1-km (i.e., half-marathon) running trial. The run started at around 7:30 AM on a mostly flat circuit (maximal slope, 1.8%), as thoughtfully described elsewhere (9). All subjects belonged to an amateur running team, and were regularly engaged in recreational running (at least 2 times a week). All subjects abstained from eating solid foods and strenuous physical activity for not less than 8 and 48 hours before the start of the trial, respectively. All diabetics were asked to continue their regular therapy with insulin and/or oral diabetes type 2 drugs throughout the period before the run. Athletes were only allowed to drink water (at libitum) throughout the running trial. Blood was drowned into evacuated blood collection tubes containing lithium-heparin as additive (Vacutest Kima s.r.l., Padova, Italy), before the start of the run and immediately after all subjects completed the trial. The blood samples were then conveyed to the service of Laboratory Medicine of the University Hospital of Verona (Verona, Italy).

Analysis of plasma lipids

All blood samples were immediately centrifuged at 1,300×g for 15 min at room temperature immediately after arrival in the laboratory. Lithium-heparin plasma was separated from the blood cell layer underneath and immediately analyzed. All measurements were performed in a single batch, with duplicate measures (final results were expressed as mean of the two measurements). Total cholesterol was measured with an enzymatic colorimetric assay (cholesterol oxidase reaction), HDL-C was assayed with a homogeneous enzymatic colorimetric assay (preliminary reaction with polyanions and detergent, followed by cholesterol oxidase reaction), whilst triglycerides were measured with an enzymatic colorimetric assay (glycerophosphate oxidase reaction). The plasma concentration of LDL-C was finally calculated according to the validated formula of Friedewald et al. (10). Post-run values were always corrected for the plasma volume change (PVC), according to the formula of Dill and Costill (11). All measurements were performed using the same Roche Cobas 6000 analyzer (Roche Diagnostics, Basel, Switzerland), during an identical analytical session. The within-run imprecision of all these assays is <1%, as quoted by the manufacturer.

Statistical analysis

Final results were normally distributed (according to Kolmogorov-Smirnov test), and were hence reported as mean and standard deviation (SD). The significance of differences was evaluated with paired or unpaired Student's t-test, when appropriate. The level of statistical significance was set at P<0.05, and the statistical analysis was performed with Analyse-it (Analyse-it Software Ltd., Leeds, UK). All athletes signed a written informed consent for participating to this trial. The study was approved by the local ethical committee (Department of Neurosciences, Biomedicine and Movement Sciences, University of Verona, Verona, Italy; protocol number 165038) and performed in accordance with the Helsinki Declaration of 1975.

Table 1 Lipoprotein fractions at baseline in euglycemic and diabetic subjects

Parameter	Euglycemic subjects	Diabetic subjects	P
Number	11	9	
Age (years)	41±6	55±14	0.012
Total cholesterol (mmol/L)	4.82±0.82	4.19±0.60	0.072
LDL-C (mmol/L)	2.78±0.75	2.31±0.52	0.135
HDL-C (mmol/L)	1.65±0.24	1.47±0.44	0.257
Triglycerides (mmol/L)	0.85±0.30	1.04±0.50	0.311

LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol.

Table 2 Percent variation of lipoprotein fractions after a 21.1-km running trial

Parameter	Euglycemic subjects		Diabetic subjects	
	Value	P vs. baseline	Value	P vs. baseline
Plasma volume	6.9±8.4%	0.032	−2.1±6.6%	0.466
Total cholesterol	1±4%	0.335	2±8%	0.455
LDL-C	−6±5%	0.001	−6±7%	0.039
HDL-C	6±4%	0.001	9±7%	0.004
Triglycerides	36±49%	0.032	30±28%	0.010

All lipid values have been corrected for the plasma volume change. LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol.

Results

Although diabetic subjects were on average 14 years older than euglycemic runners, the baseline values of all plasma lipids were found to be non-significantly different between diabetic and euglycemic subjects, as shown in *Table 1*. All athletes successfully completed the 21.1-km running trial, with running pace comprised between 9.6–12.8 km/h. The running pace did not significantly differ between diabetics and euglycemic subjects (P=0.131). The acute effect of the run on plasma volume and blood lipids is shown in *Table 2*. The plasma volume significantly increased by approximately 6.9% (P=0.032) in euglycemic subjects, whilst it remained virtually unchanged in diabetics (–2.1%; P=0.466). In both categories of subjects the values of LDL-C was found to be significantly decreased after the run, while those of HDL-C and triglycerides were significantly increased (*Table 2*). Total cholesterol remained unchanged after the run in both categories of subjects. Notably, no significant difference was noted between diabetic and euglycemic subjects in the percent post-run variation of all lipoprotein fractions after the running trial (*Figure 1*).

Discussion

Although it is now undeniable that performing regular physical exercise is associated with many positive changes of lipid profile on the long-term (12), there is less convincing information on acute changes of plasma lipids after endurance running and, especially, no data has been published on the effect of middle-distance running (i.e., between 10–21 km) on the lipid profile in both euglycemic and diabetic subjects.

Some innovative results have emerged from this study, which may have some interesting and practical clinical implications. We first showed that middle-distance running induces some acute favorable changes in the lipoprotein profile. Namely, the pro-atherogenic LDL-C fraction was found to be significantly decreased by approximately 6%, whilst the anti-atherogenic HDL-C fraction displayed an opposite trend, with a 6–9% acute increase of its values (*Table 2*). Overall, this can be classified as a beneficial shift of lipid profile towards a more favorable condition, thus providing additional evidence to that already published in marathon and ultra-marathon runners. Kuusi et al studied
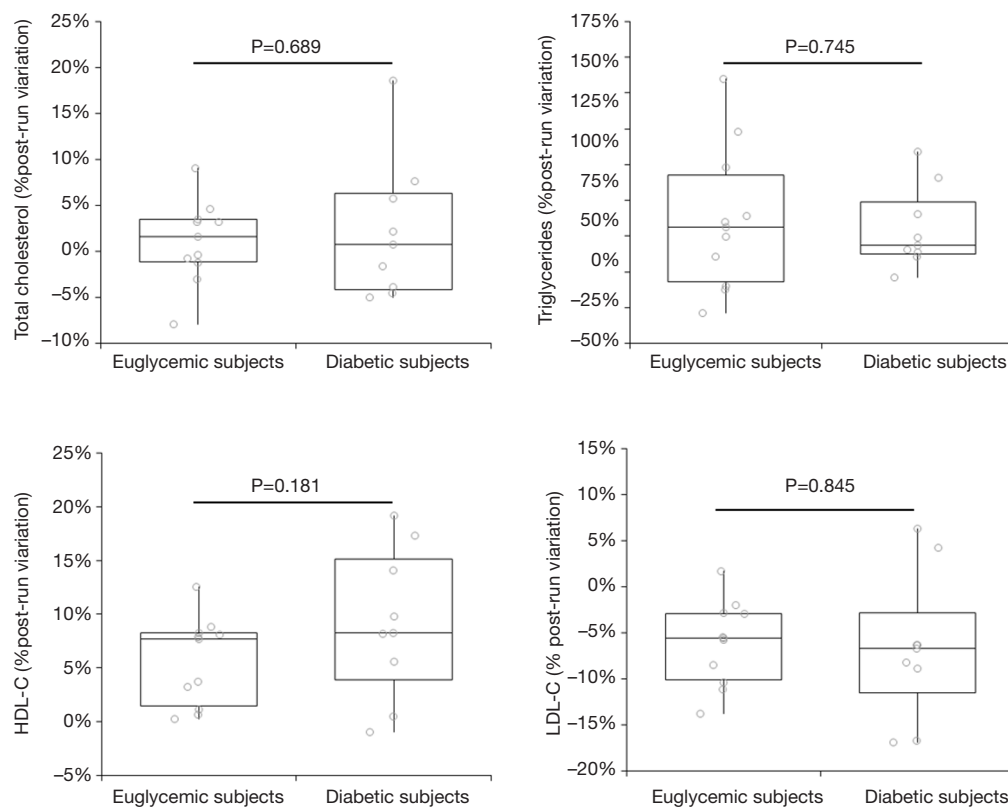
Figure 1 Percent variation of lipoprotein fractions after a 21.1-km running trial. All lipid values have been corrected for the plasma volume change. LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol.

20 healthy amateur runners who participated to the First North Karelian Heart Marathon, and showed that the HDL-C fraction significantly increased by approximately 7% at the end of the run (5). Unlike our findings, however, they failed to find any significant variation of the LDL-C fraction, which remained virtually unchanged after the end of the marathon. Notably, no significant variations were also observed for total cholesterol and triglycerides. Similar results were reported by Liu *et al.* (6), who also studied 11 well-trained male runners participating to the Helsinki City Marathon, and failed to find any significant variation in the lipid profile after completing the running distance except for HDL-C fraction, which increased by approximately 3%. In an ensuing study, Emed *et al.* studied 16 male athletes who took part to an ultramarathon run (mean distance covered, 134 km) (7), and found that neither total cholesterol or LDL-C, HDL-C and triglyceride values significantly changed after this strenuous trial, thus concluding that the lipid profile was unaltered by strenuous, long-distance running.

A second remarkable aspect emerged from our study. The acute beneficial changes of physical exercise on the lipid profile were found to be virtually identical between euglycemic and diabetic subjects, thus providing further support and reinforcing the recommendations of fostering physical activity programs in prevention and management of diabetes (13). Interestingly, our data complement those already published on the beneficial influence of a single exercise session in diabetics for increasing bioavailability of nitric oxide, eliciting reduction of blood pressure, enhancing carbohydrate oxidation and fat oxidation, thus ultimately ameliorating insulin sensitivity and glucose tolerance (14). All these acute changes, combined with evidence that middle-distance running would actually contribute to acutely ameliorate the lipid profile, persuade us to suggest that this form of exercise may be highly indicated in diabetics.

Conclusions

In conclusion, the results of our original study convincingly

show for the first time that middle-distance running elicits favorable acute changes of the lipid profile, both in euglycemic and diabetic subjects. Therefore, this form of common and sustainable endurance exercise shall be further fostered for purposes of public health promotion and improvement.

Acknowledgments

None.

Footnote

Conflicts of Interest: The other authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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