Neuroendocrinology Letters Volume 40 No. 7-8 2020
ISSN: 0172-780X; ISSN-L: 0172-780X; Electronic/Online ISSN: 2354-4716
Web of Knowledge / Web of Science: Neuroendocrinol Lett
Pub Med / Medline: Neuro Endocrinol Lett

ORIGINAL ARTICLE

The influence of meal frequency on lipid profile in the Polish population

Małgorzata Tąpolska[1], Maciej Spałek[1], Damian Skrypnik[2], Paweł Bogdański[2], Maciej Owecki[1]

1 Department of Public Health, Poznan University of Medical Sciences, Rokietnicka St. 4, 60-806 Poznań, Poland
2 Department of Treatment of Obesity, Metabolic Disorders and Clinical Dietetics, Poznan University of Medical Sciences, Szamarzewskiego St. 82/84, 60-569 Poznań, Poland

Correspondence to: Maciej Owecki, M.D., Ph.D., Professor of Medicine
Department of Public Health, Poznan University of Medical Sciences,
Rokietnicka St. 4, 60-806 Poznań, Poland
TEL.: 0048 61 658 42 75; E-MAIL: mowecki@ump.edu.pl

Submitted: 2019-08-02 Accepted: 2019-12-10 Published online: 2019-12-20

Key words: **cholesterol; triglycerides; cholesterol HDL; cholesterol LDL; dietary habits**

Neuroendocrinol Lett 2019; **40**(7-8):325–328 **PMID:** 32304369 NEL407819AX05

Abstract

OBJECTIVES: Despite numerous investigations, the influence of meal frequency on the lipid profile has not been clearly determined. The aim of the study was to investigate whether meal frequency corresponds with the lipid profile.

MATERIAL AND METHODS: The cross-sectional study enrolled 495 patients of University Hospital of Lord's Transfiguration who met inclusion criteria for study treated in 2015-2017. The subjects were divided according to meal frequency into a group consuming three or fewer meals a day and a group consuming four or more meals daily. To investigate whether there is a significant difference in cholesterol fractions and triglycerides concentrations between the mentioned groups the Mann Whitney U test was performed.

RESULTS: The group included 495 patients (66.1% women, mean age 49.9 (SD=14.7) years). The median meal frequency was 4 per day. The frequency of consumed meals a day was significantly higher for women (median 4 meals per day) than for men (3 meals per day; $p<0.0001$). A significant difference in serum triglycerides concentrations between the mentioned groups was observed ($p<0.0001$). Similarly, the difference between HDL cholesterol concentrations was presented. ($p<0.01$). No significant difference in the serum concentrations of total cholesterol and LDL cholesterol between the group consuming 3 or fewer meals and the group consuming 4 or more meals daily was seen ($p>0.05$).

CONCLUSION: We conclude that meal frequency equaling or higher than four meals daily is associated with lower fasting triglycerides and higher HDL cholesterol concentrations than consuming no more than three meals daily.

Abbreviations:

CVD	- cardiovascular diseases
MF	- meal frequency
TC	- total cholesterol
LDL	- low-density lipoprotein
HDL	- high-density lipoprotein
TG	– triglycerides

INTRODUCTION

Currently, in the world CVD are considered the main cause of death and a significant factor of deterioration in the quality of life in developed countries (Moryś *et al.* 2016; Timmis *et al.* 2018). The most important interventions that contribute to the inhibition of CVD progress include changing the lifestyle, measuring blood pressure and taking proper cholesterol-lowering medications (Cepeda-Valery *et al.* 2011). Counselling about dietary habits is seemed to be one of the best strategies to prevent and treat CVD (Ravera *et al.* 2016), due to the fact that consumed amount of calories and distribution of macronutrients can alter lipid profile (Huang *et al.* 2011; Daoud *et al.* 2014; Ravera *et al.* 2016). MF is mentioned as an important determinant in losing weight, influencing hormones levels and controlling appetite (Jakubowicz *et al.* 2012; Kulovitz *et al.* 2014). It is a common practice by physicians to advise patients about increasing MF in order to lose weight and improve metabolic parameters, however, it lacks evidence in scientific data.

On the one hand, there is research which shows that eating smaller portions more frequently can help maintain body weight and positively change lipid profile (Bhutani & Varady, 2009; Silva *et al.* 2017). Decreased insulin secretion and avoidance of excessive caloric consumption are suggested as possible mechanisms resulting from increased meal frequency that may alter lipid profile (Gwinup, 1963). Reduced insulin response is followed by decreased synthesis and activity of 3-hydroxy-3-methylglutharyl coenzyme A reductase, which contributes to decreasing LDL levels by an increase of hepatic LDL receptors (Arnold *et al.* 1993). However, the network of dependencies between individual cholesterol fractions and triglycerides makes this issue much more complex.

Conversely, other data show no impact or even negative impact on weight and appetite control of patients (Taylor & Garrow, 2001; Perrigue *et al.* 2016) and no association with lipid profile (Murphy *et al.* 1996). Concluding, much mixed scientific information about the impact of MF on our health show that research in this field is needed.

The aim of the current study was to assess whether meal frequency corresponds with the lipid profile.

MATERIAL AND METHODS

The study was carried out on a group of patients of University Hospital of Lord's Transfiguration (Poznań, Poland). The data were collected in the years 2015-2017. The study was approved by the Ethical Committee of the Poznan University of Medical Sciences (number of approval 359/15). The written informed consent was obtained from all the participants. The study was initially performed on the group of 845 adult patients, both genders. Data on each patient's anthropometric data, diseases and medications have been collected. A group of 350 subjects with the previous history of ischaemic heart disease, hypercholesterolemia, arteriosclerotic vascular disease or using any kind of medications that potentially may affect lipid profile were excluded from the research.

Serum concentrations of TC, HDL cholesterol and TG were measured for each patient in a commercial laboratory with the use of commercial kits. The measurements were performed in the fasting state (12-hour period of non-eating). The serum concentration of LDL cholesterol was calculated with Friedewald's formula. A serum concentration amounting 350 mg/dl for TG was assumed as a maximal level to reliably calculate the LDL cholesterol concentration and all LDL cholesterol measurements of participants with the concentration of TG over 350 mg/dl were excluded. A group of 495 patients were finally included in the study to analyze total cholesterol, HDL cholesterol and TG concentrations. 475 participants were analyzed concerning the LDL cholesterol level.

Each patient was asked about the number of meals consumed daily. All participants were divided according to meal frequency into a group consuming three or fewer meals a day and a group consuming four or more meals daily.

The statistical analysis was performed using Statistica 13.1 program package from Statsoft. The normality of distributions was tested using the Kolmogorov-Smirnov test. To investigate whether there is a significant difference in cholesterol fractions and triglycerides concentrations between the mentioned groups the Mann Whitney U test was performed.

RESULTS

495 participants were included in the research (66.1% female, 33.9% male). The patients aged from 19 to 89 years old. Mean age was 49.9 ((SD=14.7)) years old. The median meal frequency in the study group was 4 meals per day. The number of meals consumed daily in the study group is presented in Table I.

The frequency of consumed meals a day was significantly higher for women (median 4 meals per day) than for men (3 meals per day; $p<0.0001$). The median, minimum and maximum values of concentrations

Tab. 1. The number of meals consumed daily in the study group

Number of meals daily	N	%
1-2 meals	22	4.4
3 meals	153	30.9
4 meals	155	31.3
5 meals	142	28.7
6 meals	19	3.8
7 or more meals	4	0.8

Tab. 2. Median (minimum–maximum) values of serum cholesterol fractions' and triglycerides concentrations in mg/dl

	TC	HDL	LDL	TG
All patients	197 (76-361)	62 (13-144)	103 (25-249)	120 (26-1410)
3 or fewer meals daily	199 (117-336)	59 (31-144)	102.5 (25-199)	138 (26-1410)
4 or more meals daily	194 (76 – 361)	63 (13-132)	104 (30-249)	113 (29-727)

of cholesterol fractions and triglycerides in the examined population are shown in Table II.

A significant difference in serum triglycerides concentrations between the mentioned groups was observed ($p<0.0001$). Similarly, the difference between HDL cholesterol concentrations was presented. ($p<0.01$). No significant difference in the serum concentrations of total cholesterol and LDL cholesterol between the group consuming 3 or fewer meals and the group consuming 4 or more meals daily was seen ($p>0.05$).

DISCUSSION

Although the relationship between the number of meals consumed daily and lipid profile was investigated in a large number of studies, there is no clear evidence which would allow to unambiguously recommend any of possible meal frequency models. However, meal frequency remains one of the components of a lifestyle which may influence individual healthiness.

In our study, the highest difference between groups divided accordingly to meal frequency was presented for triglycerides concentrations. Increased eating frequency resulted in lower triglycerides serum levels. In contrary to our results it has been suggested that triglycerides concentrations are decreased in the intermittent-fasting or alternate-fasting diet (Heilbronn *et al.* 2005; Varady *et al.* 2009; Klempel *et al.* 2012; Klempel *et al.* 2013; Eshghinia & Mohammadzadeh, 2013). Notwithstanding, in the mentioned studies the calorie restriction was performed and the triglycerides reduction was achieved in parallel to weight loss. In the research by Stote *et al.* (2007) there was no significant difference in effect on TG levels between 1 meal/daily and 3 meals/daily groups with the same calories intake. Farshchi *et al.* (2004) assessed how MF alters circulating lipids in a group of healthy lean women eating 3-9 meals/d with the same energy intake and showed that there was no significant difference in TG levels. The intake of calories, therefore, seems to be an important factor affecting the concentration of triglycerides, which results in divergent results depending on the group of patients and administered diets.

There are investigations which discussed the impact of meal frequency on total cholesterol and LDL cholesterol concentrations (Jenkins *et al.* 1989; Arnold *et al.* 1993; McGrath & Gibney, 1994). In the study by Jenkins *et al.* (1989), consuming 17 meals a day for two weeks notably reduced TC and LDL concentrations. It has been also reported that the frequency of eating 9 meals (Arnold *et al.* 1993) or 6 meals daily (McGrath & Gibney, 1994) may result in a decrease of TC and LDL. What is more, it was presented by Stote *et al.* (2007) that patients who ate all calories in 1 meal a day had an increase of TC and LDL levels. A cross-sectional study, which was conducted in the Norfolk population of the European prospective investigation into cancer (EPIC-Norfolk), in which almost 15 thousand of participants were included, showed an inverse relation between MF and concentrations of TC and LDL (Titan *et al.* 2001). In our study, a significant association of MF with TC and LDL concentrations was not reported, which can be explained by the fact that most of our participants declared consuming 3 to 5 meals daily.

We observed that our patients had significantly higher values of HDL when they consumed 4 or more meals a day compared to the second group. Reports on the relationship between meal frequency and HDL cholesterol concentrations are inconsistent. In some studies the impact of the increase in meal frequency on HDL levels was not observed (Arnold *et al.* 1994; Titan *et al.* 2001; Farshchi *et al.* 2005). Interestingly, increases in HDL cholesterol were also observed with a reduction in meal frequency (Murphy *et al.* 1996; Stote *et al.* 2007). The reason why reduced meal frequency could increase HDL concentrations has not been clarified, which implicates that the issue needs further research (Stote *et al.* 2007).

CONCLUSIONS

We conclude that meal frequency equaling or higher than four meals daily is associated with lower fasting triglycerides and higher HDL cholesterol concentrations than consuming no more than three meals daily. Our study shows that using a diet with a least four meals daily may contribute to maintaining a favourable lipid profile. However, to clarify the issue further research will be necessary.

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