Comparison of Fatty Acid Profiles between Successful and Usual Aging Elderly

(Perbandingan Profil Asid Lemak antara Orang Tua Penuaan Berjaya dan Biasa)

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ABSTRACT

Increased the consumption of polyunsaturated (PUFA) and omega-3 fatty acid may be one of the strategies to prevent morbidity and mortality among elderly. This study aimed to identify the plasma fatty acid profile and intake among older adults who aged successfully (SA) as compared to the usual agers (UA). This cross-sectional comparative study was conducted among 48 SA (mean age 66.4±4.7 years old) and 42 UA (mean age 68.4±4.8 years old). The plasma fatty acid profile was determined using gas chromatography. Fatty acid intake was measured by using the validated Fatty Acid Omega-3 intake food frequency questionnaire. The percentage of saturated fatty acids (SFA) in blood plasma of UA (men 62.2±6.4%, women 62.9±7.0%) were significantly higher (p<0.05) compared to SA (men 53.7±15.8%, women 57.1±9.5%). On the other hand, the percentage of monounsaturated (MUFA), polyunsaturated (PUFA) omega-3 and omega-6 fatty acids were the opposites. Fatty acids intake among SA was higher compared to UA. SFA (SA=5.0±2.5%, UA=4.6±2.9%) and total omega-3 (SA=0.5±0.4%, UA=0.4±0.3%) intakes met the recommended nutrient intake (RNI). However, mean intakes of MUFA (SA=5.3±2.4%, UA=4.7+2.7%) and linoleic acid (LA) (SA=0.5±0.7%, UA=0.3±0.5%) were below than the RNI. Percentages of subjects who did not meet the RNI for omega-3 and MUFA were 44.2% and 97.7% for SA and 47.4% and 95% for UA, respectively. SA had a higher level of plasma PUFA and MUFA, but lower in SFA when compared to UA. MUFA and LA were more likely to be inadequate in the diet of older adults, particularly the UA.

Keywords: Elderly; fatty acid; omega-3; successful aging; usual aging

ABSTRAK

Meningkatkan pengambilan asid lemak politaktepu dan asid lemak omega-3 berkemungkinan merupakan salah satu strategi untuk mencegah morbiditi dan mortaliti dalam kalangan warga emas. Kajian ini bertujuan untuk mengenal pasti profil asid lemak plasma dan pengambilan asid lemak dalam kalangan warga emas penuaan berjaya (SA) berbanding penuaan biasa (UA). Kajian perbandingan hirisan lintang ini dijalankan ke atas 48 orang warga emas SA (purata umur 66.4±4.7 tahun) dan 46 orang warga emas UA (purata umur 66.4±4.7) tahun ini. Profil asid lemak ditentukan menggunakan kromatografi gas. Pengambilan asid lemak pula diukur menggunakan borang soal selidik Kekerapan Pengambilan Makanan Asid Lemak Omega-3 yang telah disahkan. Peratusan asid lemak tepu (SFA) dalam plasma darah warga emas UA (lelaki 62.2±6.4%, wanita 62.9±7.0%) adalah lebih tinggi secara signifikan (p<0.05) berbanding SA (lelaki 53.7±15.8%, wanita 62.9±7.0%). Manakala peratusan komposisi asid lemak monotaktepu (MUFA), politaktepu (PUFA), omega-3 dan omega-6 adalah sebaliknya. Pengambilan asid lemak adalah lebih tinggi dalam kalangan SA berbanding UA. Pengambilan SFA (SA=5.0±2.5%, UA=4.6±2.9%) dan omega-3 total (SA=0.5±0.4%, UA=0.4±0.3%) menepati Saranan Pengambilan Nutrien (RNI). Walau bagaimanapun, purata pengambilan MUFA (SA=5.3±2.4%, UA=4.7±2.7%) dan asid linoleik (LA) (SA=0.5±0.7%, UA=0.3±0.5%) pula adalah lebih rendah berbanding RNI. Peratusan subjek yang tidak memenuhi RNI bagi omega-3 dan MUFA pula adalah sebanyak 44.2% dan 97.7% bagi SA manakala 47.4% dan 95% bagi UA. Kesimpulannya warga emas SA mempunyai tahap PUFA dan MUFA plasma yang tinggi, tetapi rendah tahap SFA berbanding warga emas UA. Pengambilan MUFA dan LA adalah tidak mencukupi dalam diet warga emas, khususnya UA.

Kata kunci: Asid lemak; penuaan Berjaya; penuaan biasa; omega-3; warga emas

INTRODUCTION

Malaysia is one of the countries where its population is aging and is expected to be the aging nation in 2030 when 15% of the population is classified as older adults (Samad & Mansor 2013). According to the Department of Statistics Malaysia (2016), 6% of 31.7 million Malaysian citizens are comprised of older adults aged 65 years and above. Aging is a complex process (Lacruz et al. 2010).

As we grow older, lots of physiological changes happened and the risk of having disease also increases (WHO 2015). However, if ones can aged successfully, the implications was not only toward the individual, it also give positive effects to the community (Fielding et al. 2011; Gavrilova & Gavrilov 2010).

The definition and determinants of successful aging is still controversial (Tyrovolas et al. 2014). Rowe and

Kahn's successful aging concept is one of the popular successful aging model (Cosco et al. 2013). It focuses on high cognitive physical function, low risk of disease and active engagement with the community (Rowe & Kahn 1997, 1987). It is widely accepted that dietary patterns are associated with healthy aging (Sofi et al. 2013). However, there is lack of evidence on the role of dietary habits in successful aging (Tyrovolas et al. 2014). One of the dietary patterns that has been extensively studied and associated with longevity is the Mediterranean diet. Higher adherence to this traditional diet is associated with lower overall mortality, reduced risk of cardiovascular diseases and neoplastic diseases (Sofi et al. 2013).

Omega-3 fatty acid is known as a nutrient that has potential to prevent pathological condition that relate to aging process. This fatty acid protects and maintains a better health condition (Ubeda et al. 2012). The intake of foods containing omega-3 among the elderly can help them to improve the quality of life and reduce problems such as depression. It may also help to treat the psychological disease (Freeman 2006). However, little is known about the fatty acids profile and intake among Malaysian older adults and whether these profiles were better among the successful agers. Thus, this study aimed to determine the plasma fatty acid profile and also its intake among successful agers, as compared to the usual agers. Furthermore, correlations between the plasma fatty acid profile and its intake were also determined.

MATERIALS AND METHODS

STUDY DESIGN AND RESPONDENTS

This cross-sectional study was conducted among older adults recruited using multistage random sampling from three states of Peninsular Malaysia, i.e. Kelantan, Perak and Selangor. These subjects were part of the Longitudinal Research Grant Scheme Towards Useful Aging (LRGS TUA) that commenced in July 2013. Written consent was obtained from each subject and the study was approved by the Universiti Kebangsaan Malaysia Medical Committee's (UKMMC) Ethical Committee (1.5.3.5/244/NN-060-2013). Eligible subjects were randomly selected and invited to participate for a screening at the respective community centers. Inclusion criteria were aged 60-years and above; had no mental illness; no serious disease and physical disability; able to read and listen well. Those who change their dietary habits one month prior to data collection and take fish oil supplements were excluded. Subjects were interviewed to collect data on socio-demographic and dietary intake.

CLASSIFICATION OF SUCCESSFUL AND USUAL AGING

Respondents were classified to particular aging groups according to study reported by Shahar et al. (2015). It was based on the categorization of successful aging (SA) by Hamid et al. (2012), i.e. free from major chronic diseases and has better quality of life and at least feel good about their health. Whilst those who were not met the criteria of successful aging, were categorized as usual aging (UA) (Sun et al. 2010, 2009). A subsample of 48 SA was randomly chosen for fatty acids analysis. A total of 42 UA matched for age and gender; was recruited as comparison through a cross sectional comparative study design. Subjects were also asked to fast for at least 12 h before the blood collection. However, plain water consumption was allowed. Blood samples were collected in the morning and the plasma samples were stored at -80°C until analyzed.

FATTY ACID INTAKE ASSESSMENT AND ANALYSIS

Fatty acid intake was assessed using a validated omega-3 intake food frequency questionnaire (Lee et al. 2013). The questionnaire contains 43 food items which categorized under 5 food groups which is fish and seafood, vegetable oils, vegetables, meat and egg and dairy products. US Department of Agriculture Nutrient Database (USDA 2007) was used to analyze the mean intake of fatty acids while the portion size of each food item was based on Malaysian Food Composition Table (Tee et al. 1997). Mean intake of fatty acids, i.e. saturated fatty acids (SFA), monounsaturated fatty acids (MUFA), polyunsaturated fatty acids (PUFA), omega-3, linoleic acid (LA), alpha-linolenic acid (ALA), eicosapentanoic acid (EPA) and docosahexanoic acid (DHA) were measured based on the energy intake of the elderly.

PLASMA FATTY ACIDS ANALYSIS

Blood samples were collected in the morning after 12 h fast. Plasma samples were stored at -80°C until analyzed. Determination of plasma fatty acids were carried out involving three main procedures, i.e. the extraction of lipids, the transesterification of methyl ester and gas chromatography analysis. 200 µl of blood plasma was used to extract lipids according to Folch et al. (1957) followed by the transesterification of the lipids into fatty acid methyl ester (FAME) described by Lepage and Roy (1984).

Separation of FAME was carried out on PerkinElmer Clarus 680 gas chromatograph equipped with flame ionization detector and cyanosiloxane capillary column merged (100 meter length, 0.25 mm external diameter and 0.2 µm internal diameter of SP-2560, Supelco) was used to analyse fatty acids. The initial column temperature was 50°C, being afterwards increased to 200°C, at a rate of 3°C/min, in which was maintained for 5 min. The temperature of the oven was raised to 220°C, at a rate of 3°C/min, maintained for 17 min. The peaks were identified by comparison of the times retention with the standard solution containing 37 FAME components, Supelco 37 Component FAME Mix (47885-U) in methylene chloride. The flow rates of the gases used were as following: 2 mL/min for hydrogen gas, 450 mL/min for purified air. One cycle of the analysis lasts about 78.67 min per sample.

The amount of plasma fatty acids, ranging from C4:0 to C22:6n-3, is expressed as percentage of total fatty acids. Plasma saturated fatty acids (SFAs), monounsaturated fatty acids (MUFAs), polyunsaturated fatty acids (PUFAs), omega-3 fatty acids and omega-6 fatty acids were calculated. In this present analysis, we considered the percentage of individual fatty acids: linoleic acid (LA), alpha-linoleic acid (ALA), eicosapentanoic acid (EPA) and docosahexanoic acid (DHA).

STATISTICAL ANALYSIS

The statistical analyses were conducted using the Statistical Package of Social Science (SPSS) version 23. Descriptive data are presented as mean $\pm$ standard deviations (SD) or percentage. Normality test was observed based on skewness and kurtosis and Shapiro-wilk test. Not normally distributed data were log-transformed. All data are normally distributed with the exception of ALA, EPA and DHA which were log-transformed. Differences between groups were tested with an independent t-test and two-way ANOVA. The Pearson correlation test was used to determine the association between the plasma fatty acid composition and fatty acid intake. Categorical data were analyzed using the Chi-squared test.

RESULTS

There were 90 subjects consisted of 48 SA (66.4±4.7 years) and 42 UA (68.4±4.8 years) who were involved in this study. As shown in Table 1, 26 subjects (54.2%) in SA group were men and 22 of SA subjects were women (45.8%). In UA group, the number of women subjects (n=24) were higher compared to men (n=18). This study involved participants from various ethnicities. In SA group, 52.1% of the subjects were Chinese followed by Malay (37.5%), Indian (8.3%) and other ethnicity which is Portuguese (2.1%). While in UA group, half of the subjects were Malay (57.1%) and the rest were Chinese (28.6%) and Indian (14.3%). The Chi square test showed a significant different (p<0.05) between the education level and the aging group. Most of the SA subjects have education at the secondary level (39.6%) while half of the UA subjects have education at the primary level (52.4%). Majority of the subjects were married (77.0% among SA and 71.4% among UA); not working due to retirement (83.3% among SA and 81.0% among UA); and had a total household income below RM2000 (77.1% among SA and 88.1% among UA).

TABLE 1. Socio-demographic profile of subjects by aging group

Parameter	Aging group		Total (n=90)
	Successful aging (n=48)	Usual aging (n=42)	
Age (Mean±SD)	66.4 ± 4.7	68.4 ± 4.8	67.3 ± 4.8
Gender			
Men	26 (54.2)	18 (42.9)	44 (48.9)
Women	22 (45.8)	24 (57.1)	46 (51.1)
Ethnicity			
Malay	18 (37.5)	24 (57.1)	42 (46.7)
Chinese	25 (52.1)	12 (28.6)	37 (41.1)
Indian	4 (8.3)	6 (14.3)	10 (11.1)
Others	1 (2.1)	0 (0.0)	1 (1.1)
Marital Status			
Married	37 (77.0)	30 (71.4)	67 (74.4)
Divorced/Widowed	11 (23.0)	12 (28.6)	23 (25.6)
Single			
Education			
No formal education	3 (4.2)	6 (13.6)	9 (10.0)
Primary	16 (33.0)	22 (52.4)*	38 (42.2)
Secondary	19 (39.6)	12 (28.6)	31 (28.6)
Tertiary	10 (20.8)	2 (4.8)	12 (13.3)
Working status			
Working	8 (16.7)	8 (19.0)	16 (17.8)
Not working/Retired	40 (83.3)	34 (81.0)	74 (82.2)
Household income			
Less than RM2000	37 (77.1)	37 (88.1)	74 (82.2)
More than RM2000	11 (22.9)	5 (11.9)	16 (17.8)

*p<0.05, significant different between the aging group, Chi Square test

TABLE 2. Comparison of plasma fatty acid profile between aging group and gender

Fatty acid (%)	Gender	Successful aging (n=48)	Usual aging (n=42)
SFA	Men	53.7 ± 15.8	62.2 ± 6.4
	Women	57.1 ± 9.5	62.9 ± 7.0*
MUFA	Men	16.2 ± 9.3	16.3 ± 4.4
	Women	14.9 ± 6.2	14.2 ± 4.5
PUFA	Men	27.4 ± 9.3*	22.3 ± 5.4
	Women	24.4 ± 5.0	21.6 ± 5.3
Omega-3	Men	3.6 ± 3.0	2.0 ± 1.7
	Women	2.7 ± 1.7	2.8 ± 1.9
Omega-6	Men	24.1 ± 8.5*	19.4 ± 4.7
	Women	21.6 ± 5.4	18.6 ± 5.7
LA	Men	18.5+5.8*	14.4+3.2
	Women	16.3+3.8	13.7+4.4
ALA[a]	Men	0.2+0.3	0.5+1.2
	Women	0.2+0.1	0.6+1.7
EPA[a]	Men	0.5+1.2	0.1+0.1
	Women	0.4+0.5	0.3+0.3
DHA[a]	Men	1.6+1.3	1.1+0.7
	Women	2.0+1.4*	1.0+0.8

*$p<0.05$, significant different between aging group within the same gender, Two-way ANOVA
[a] Variables were log-transformed before analysis because data were not normally distributed
SFA = Saturated fatty acid, MUFA = Monounsaturated fatty acid, PUFA = Polyunsaturated fatty acid, LA = Linoleic acid,
ALA = alpha-Linolenic acid, EPA = Eicosapentanoic acid, DHA = Docosahexanoic acid

PLASMA FATTY ACID PROFILE

A two-way ANOVA was conducted to examined the effect of gender and aging group on the plasma fatty acid composition (Table 2). There was a statistically significant difference in between the aging group with SFA $F(1,86)=9.74$, $p=0.002$, PUFA $F(1,86)=7.62$, $p=0.007$, omega-6 $F(1,86)=8.15$, $p=0.005$ and LA $F(1,86)=12.16$, $p=0.001$. Besides, there was a statistically significant interaction $F(1,86)=9.03$, $p=0.003$, between the effects of aging group and gender on the plasma fatty acid composition.

FATTY ACID INTAKE

All types of fatty acids intake were higher among the SA group. SFA (5.0±2.5% for SA and 4.6±2.9 for UA) and omega-3 (0.5±0.4% for SA and 0.4±0.3%) intake met the recommendation of the recommended nutrient intake (RNI) for Malaysian. MUFA (5.3±2.4% for SA and 4.7±2.7% for UA) and LA (0.5±0.7% for SA and 0.3±0.5% for UA) intakes did not achieve the recommendation (Table 3). Percentages of subjects who did not meet the RNI for omega-3 and MUFA were 44.2% and 97.7% for SA and 47.4% and 95% for UA while 100% of subjects did not meet the RNI for LA. Only 4.7% of SA elderly and 5% of UA elderly did not met the recommendation of SFA. Fish and seafood contributed the highest percentage to the omega-3 intake (51.5% for SA and 58.9% for SA), followed by vegetables, milk and dairy products, meat and eggs and the least contributor to the percentage of omega-3 intake was the vegetable oils.

The percentage of milk and dairy products to the omega-3 intake were significantly ($p<0.05$) higher among the SA group (13.8%) compared to UA group (4.9%).

CORRELATION BETWEEN FATTY ACID INTAKE AND FATTY ACID COMPOSITION IN PLASMA

LA intake showed a positive significant ($p<0.05$) relationship with the composition of PUFA ($r=0.246$), omega-6 ($r=0.241$) and LA ($r=0.262$) in plasma. Besides, DHA intake also showed a moderate positive significant ($p<0.01$) relationship with the PUFA ($r=0.325$), omega-6 ($r=0.367$) and LA ($r=0.390$) in plasma (Table 4).

DISCUSSION

The percentage of plasma fatty acids among elderly in this study were close to the findings of the previous studies which have the same range of age (Nirupa et al. 2014; Rise et al. 2013). The composition of PUFA, omega-3 and omega-6 in plasma were higher among SA elderly compared to UA. These findings were similar to the Cunnane et al. (2012) who found the higher composition of MUFA and omega-6 among elderly who did not have cognitive deficit problem. In addition, the composition of SFA was higher among women subjects in both groups compared to men. This was in contrast to study by Saadatian-Elahi et al. (2009) who reported that the SFA composition was higher among men subjects compare to women. The different composition of plasma fatty acids among sexes may be due

TABLE 3. Percentage of fatty acid consumption based on energy intake by aging groups

Parameter	Aging group		RNI (NCCFN 2017)
	Successful aging (*n*=48)	Usual aging (*n*=42)	
SFA (%)	5.0 ± 2.5	4.6 ± 2.9	<10%
MUFA (%)	5.3 ± 2.4	4.7 ± 2.7	12-15%
PUFA (%)	3.0 ± 1.4	2.9 ± 1.7	-
Total omega-3 (%)	0.5 ± 0.4	0.4 ± 0.3	0.3-1.2%
LA (%)	0.5 ± 0.7	0.3 ± 0.5	3-7%
ALA (%)	1.7 ± 10.6	0.02 ± 0.03	-
EPA (%)	0.0005 ± 0.001	0.0002 ± 0.0004	-
DHA (%)	0.003 ± 0.006	0.002 ± 0.003	-

to the dietary habits as well as the fatty acid metabolism that differ between men and women. The rate of omega-3 PUFA synthesis was higher in women (Childs et al. 2008) and the estrogen hormones will further increase the conversion of ALA to DHA (Kitson et al. 2010).

Though the omega-3 fatty acids intake met the recommendation of 0.3-1.2% of energy intake, the value was still low, with 44.2% of SA and 47.4% of UA did not meet the RNI. Findings of this study were in agreement with earlier study by Lee et al. (2013) among older adults residing low cost housing area in Klang Valley of Malaysia. As shown in Figure 1, almost half of the subjects in both aging groups did not meet the recommendations of RNI for omega-3 intake. Their intake of omega-3 only achieved 0.5% (SA) and 0.4% (UA) of the recommendations. However, the problem of this inadequacy of omega-3 intake was not just among the elderly, about average Malaysian's intakes of omega-3 remains low and there are several ways that we can remedy this, namely: consuming more pulses (e.g. beans, dhal), tofu and fishes and use a cooking oil that is a blend of palm olein + n-3 rich vegetable oil (e.g. canola, soybean) (NCCFN 2017).

The intake of MUFA was much lower than the RNI and this may due to the fact that oils high in MUFA i.e. olive (76%), mustard (70%), almond (69%), canola (62%) and groundnut (50%), are not the main cooking oil in Malaysia. Food and Agriculture Organization (FAO) (2011) reported palm oil represents the main cooking oils for most Malaysians, as this country is a primary producer of palm oil. The same goes to LA which mainly comes from vegetables oils such as soybean and canola oils.

Besides that, the intake of SFA was also within the RNI recommendation of <10% of energy intake and fewer subjects did not meet the recommendation of SFA. Similar to the findings of Micha et al. (2014) where the intake of SFA was about 9.2-9.5% for Malaysian adults, however, with this number, Malaysia was still one of the countries with the highest intake of SFA. This study had no problems of under-reporting or over-reporting for both aging groups. Fish and seafood contributed most of the percentage of omega-3 intake followed by vegetables, milk and dairy products, meat and eggs and also vegetable oils. This finding was different from the Australian population where almost 50% of their omega-3 intake came from meat sources (Howe et al. 2006).

SFA and MUFA have a negative correlation with consumption. As expected, the SFA and MUFA in plasma did not reflect their consumption in the diet and the results
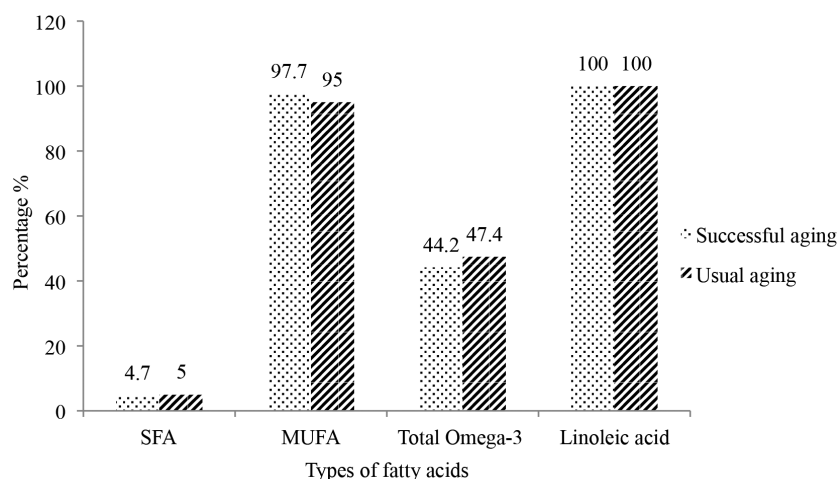

FIGURE 1. Percentage of subjects did not meet the fatty acids recommendation

TABLE 4. Correlation between fatty acids intake with fatty acid composition in plasma

PARAMETER	SFA intake	MUFA intake	PUFA intake	Omega-3 intake	LA intake	ALA intake	EPA intake	DHA intake
	r	r	r	r	r	r	r	r
Plasma SFA	-0.027	-0.203	-0.122	-0.113	-0.074	0.055	-0.044	-0.253*
Plasma MUFA	-0.009	0.063	0.110	0.028	-0.031	-0.015	-0.144	-0.028
Plasma PUFA	0.053	0.239*	0.087	0.181	0.246*	-0.048	0.092	0.325**
Plasma omega-3 total	0.015	-0.054	-0.076	-0.133	-0.080	-0.069	-0.073	-0.034
Plasma omega-6 total	0.016	0.224*	0.113	0.156	0.241*	-0.026	0.135	0.367**
Plasma LA	0.026	0.211	0.076	0.099	0.262*	-0.028	0.166	0.390**
Plasma ALA	-0.016	-0.017	0.001	-0.089	-0.101	-0.037	-0.054	-0.039
Plasma EPA	-0.120	-0.138	-0.151	-0.084	-0.087	-0.084	-0.081	0.007
Plasma DHA	-0.009	-0.080	-0.099	0.009	-0.073	-0.017	-0.064	-0.019

*$p < 0.05$, **$p < 0.01$, significant correlation between fatty acids intake and fatty acids composition in plasma, Pearson correlation test

of this study were supported by Sun et al. (2007). SFA and MUFA were not considered as a good biomarker to reflect the consumption of foods because it can be produced by the body through carbohydrates. However, some fatty acids like PUFA, omega-6, omega-3 and odd saturated fatty acids (C15:0 & C17:0) were good biomarkers (Baylin & Campos 2006). Essential fatty acids such as LA were expected to show a direct correlation between plasma concentration and the food intake (Saadatian-Elahi et al. 2009). This study found a positive significant correlation between the intake of LA and DHA with the composition of PUFA, total omega-6 and LA in plasma. Similarly, Sun et al. (2007) found a positive correlation (r=0.26) between LA composition in plasma and its intake. However, a perfect correlation between the composition of fatty acids in the tissues and blood with its intake was unrealistic (Sun et al. 2007). This was because there were other factors that affect the composition of fatty acids such as genetics, smoking, physical activity and metabolism (Hodson et al. 2008).

CONCLUSION

Successful aging was associated with a higher MUFA, PUFA and lower SFA in plasma. SA had a higher consumption of all types of fatty acids. Regardless of aging groups, SFA and omega-3 but not MUFA and LA met the recommended intake for Malaysian population. Composition of LA in plasma reflected its intake in the diet. There is a need to promote consumption of fish, seafood and nuts as good sources of fatty acids that lead to successful aging.

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