Int J Clin Exp Med 2015;8(2):2823-2830
www.ijcem.com /ISSN:1940-5901/IJCEM0004010

Original Article

Ethnic differences in acylation stimulating protein (ASP) in Xinjiang Uygur autonomous region, China

Ying Gao[1], Xiang Xie[1], Katherine Cianflone[2], Marc Lapointe[2], Jie Guan[1], Gao Wa Bai Bu-jiaer[1], Dan Chen[1], Wei-Yun Zhao[1], Yi-Tong Ma[1]

[1]Department of Cardiology, First Affiliated Hospital of Xinjiang Medical University, Urumqi 830011, People's Republic of China; [2]Centre de Recherche Institut Universitaire de Cardiologie et de Pneumologie de Québec (CRIUCPQ), Laval University, Québec, Québec, Canada

Received November 20, 2014; Accepted January 28, 2015; Epub February 15, 2015; Published February 28, 2015

Abstract: Background: Acylation Stimulating Protein (ASP) stimulates adipocyte triglyceride synthesis and glucose transport. The aim was to examine ethnic difference in ASP and the relation to lipid profile and other parameters among Han, Uygur, and Kazak healthy populations matched for BMI, age and gender distribution. Methods: 331 healthy persons were recruited in total (age 30-60 yr): 137 Han, 114 Uygur, and 80 Kazak. Anthropometric measurements including height, weight, waist circumference, hip circumference, blood pressure, ankle brachial index (ABI), and pulse wave velocity (PWV) were measured in all participants. Fasting concentrations of fasting glucose, uric acid, and lipids, including triglyceride (TG), total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), high density lipoprotein cholesterol (HDL-C), ASP, complement C3, insulin, non-esterified fatty acid (NEFA) and C-reactive protein (CRP) were measured. Results: ASP in Uygurs was significantly lower than Han subjects (P=0.0003). The Uygurs demonstrated the highest C3 (P<0.001), CRP (P=0.001), and NEFA concentrations (P=0.008), the lowest %ASP/C3 (P<0.001) and TC levels (P=0.0008) vs those in Han and Kazak populations. In the Han group, glucose, the average ABI (an index of peripheral response) and diastolic blood pressure were significantly different from both Uygur and Kazak group (P=0.0007, P=0.0003, P=0.0001) while Kazaks show the lowest waist/hip circumference (WHR) (P=0.0003). Conclusion: There are ethnic differences in ASP, C3, CRP and lipid profiles in healthy Han, Uygur, and Kazak populations. Overall, the Uygur populations presents with a disadvantageous metabolic profile as compared to Han and Kazak groups.

Keywords: Acylation stimulating protein (ASP), ethnicity, C3

Introduction

In China, the Hans constitute a large majority of the population, however, there are many minority groups ranging from several thousand to many million. Within these groups, there is a range in life expectancies as reported a number of years ago [1]. These variations in life expectancy are also associated with different diseases. Xinjiang, with more than 13 national minority groups living in the area, is in the Northwestern area of China. Among them, the Uyger people account for 46%, the Hans account for 40%, and the Kazaks account for 7%. In spite of the presence of these people in the same geographic area, each group is relatively distinct with little intermingling. Interestingly, this distinctiveness is also reflected by differences in incidence of disease, with a number of studies focusing principally on the Han, Uyger and Kazak populations.

In adults, the prevalence of overweight was highest in the Han male population and the rate of obesity in Kazak male population was the highest [2]. While investigations in school children aged 8-18 years in Urumqi revealed that the prevalence of obesity was lower than the national average level and the level in Western countries, nonetheless, Han boys and Hui girls had the highest prevalence of obesity and Kazak boys had the lowest prevalence [3].

The prevalence of hypertension was notably higher in Kazak people (43.5%) than in Uyger people (32%) [4]. The prevalence of glucose intolerance in Uygurs was 1.9-fold higher than in the Kazak population (3.29 vs. 1.73%) as

reported in 2008 [4]. Further, the prevalence of insulin resistance (IR) was 42.6% and 31.9% in Uygurs and Kazaks [5]. Yan et al [6] showed that Uygurs have a higher incidence of metabolic syndrome (8.6%) relative to Kazaks (4.8%). Results from the Cardiovascular Risk Survey (CRS) on multiple-ethnic study reported that the prevalence of type 2 diabetes was 9.26% in Han, 6.23% in Uygur and 3.65% in Kazak [7].

Studies on lipid profiles in the complete Xinjiang population [8, 9] indicate the Han and Uygur ethnicities in Xinjiang had higher triglyceride (TG), lower high density lipoprotein cholesterol (HDL-C), while the Kazak population had lower triglyceride (TG), higher total cholesterol (TC), high density lipoprotein cholesterol (HDL-C) and low density lipoprotein cholesterol (LDL-C).

Remarkably, considering the ethnic differences in overweight, obesity and related metabolic diseases, there has been very little evaluation of adipokines. The adipose tissue has been widely recognized as a metabolically active organ producing numerous secreted proteins, enzymes and hormones [10]. Both human and murine adipose tissue have been shown to synthesize and secrete complement C3, factor B, and adipsin, proteins involved in the alternate complement pathway [11, 12]. Acylation-stimulating protein (ASP), identical to C3adesArg, is the product of N-terminal cleavage of complement C3 through its interaction with factors B and D (or adipsin) [13, 14]. ASP is an adipose tissue-derived hormone that stimulates adipocyte triglyceride synthesis and glucose transport [10]. Both ASP and its precursor C3 have been demonstrated to be associated with obesity, diabetes and cardiovascular disease [10]. Moreover, ASP is reported to correlate with body mass index (BMI), TG, LDL-C and non-esterified fatty acid (NEFA) [10, 15, 16]. So far, no data exists on ASP in healthy Han, Uygur and Kazak ethnic populations.

To better understand the metabolic characteristics in Han, Uygur and Kazak ethnic populations within an expanded geographical distribution, this study was designed to evaluate and compare metabolic factors, such as ASP, C3, insulin, C-reactive protein (CRP), and NEFA in Han, Uygur and Kazak healthy populations from multiple counties within the Xinjiang region.

Subjects and methods

Subjects

Healthy Chinese subjects were recruited from six cities (Urumqi, Kelamayi, Hetian, Zhaosu, Fukang, Tulufan). We used a stratified sampling method to select samples of the general population of Chinese Hans, Uygurs, and Kazaks of this area. A total of 13618 participants (5750 Hans, 4767 Uygurs, and 3101 Kazakhs), were randomly selected from 26 villages of these cities and were invited to participate. Institutional review board approval was obtained from the Ethical Committee of the First Affiliate Hospital of Xinjiang Medical University, and all subjects provided informed consent. A set of questionnaires, including age, gender, education, home address, ethnicity, occupation, and household income, family disease history, history of diseases, medication compliance, smoking, alcohol consumption, and anthropometric measurements including height, weight, waist circumference, hip circumference, and blood pressure were collected from all participants. Ankle Brachial Index (ABI: right, left and average) and Pulse Wave Velocity (PWV: right, left and average) were measured as described previously [17]. After overnight fasting (minimum 8 hours), a 5 mL peripheral blood sample was collected with an EDTA vacutainer tube. The fasting blood samples were kept in a portable styrofoam box with ice packs (0-4°C), and processed within 4 h. After processing, samples were immediately stored at -80°C until analysis. Concentrations of fasting glucose, uric acid (UA), and lipids, including triglyceride (TG), total cholesterol (TC), low density lipoprotein cholesterol (LDL-C), and high density lipoprotein cholesterol (HDL-C) were measured by the Clinical Laboratory Department of the First Affiliated Hospital of Xinjiang Medical University. Type 2 diabetes was defined according to the American Diabetes Association (ADA) 2009 criteria [18] as fasting plasma glucose ≥7.0 mmol/L or self-reported current diabetes treatment in the survey. Hypertension was identified using 2010 Chinese guidelines for the management of hypertension [19]. Dyslipidemia was defined based on the 2007 China Adult Dyslipidemia Prevention Guide criteria [20]. For the present study, subject inclusion criteria were: age (30-60 years), BMI (23-25 kg/m^2), no hypertension, no type 2 diabetes, no hyperuricemia, no hypertri-

Table 1. Clinical and laboratory data in subjects

	Han	Uygur	Kazak
n	137	114	80
Age (yr)	44.44±6.15	44.14±7.71	42.20±7.72
Sex (female %)	61	62	61
BMI (kg/m^2)	24.02±0.54	24.00±0.59	23.96±0.61
WHR (cm/cm)	0.88±0.11	0.88±0.06	0.83±0.09***,^{aa}
SBP (mmHg)	122.91±16.26	124.90±16.20	124.89±17.56
DBP (mmHg)	81.32±8.63	75.61±12.49**	76.30±13.45*
ABI (Average) (mmHg/mmHg)	1.07±0.08	1.02±0.13***	1.03±0.08*
PWV (Average) (cm/s)	1325.80±238.58	1386.42±283.58	1306.73±205.10
ASP (nM)	1.23±0.96	0.88±1.12***	1.08±1.03
C3 (g/L)	1.28±0.29^{aa}	1.39±0.27	1.16±0.28^{aaa},*
%ASP/C3	1.03±0.86^{aaa}	0.64±0.86	1.04±1.16^{aa}
CRP (mg/L)	2.80±3.32^{aa}	5.56±12.09	4.71±7.80^{aa}
Insulin (IU/ml)	7.05±4.33	8.95±4.89	11.7±8.89***,^{aaa}
Glucose (mmol/L)	4.81±0.6	4.54±0.78**	4.70±0.68
uric acid (umol/L)	283.69±65.17	220.18±62.13	232.93±64.53
TG (mmol/L)	1.03±0.36	1.01±0.38	0.95±0.38
TC (mmol/L)	4.12±0.64^{aaa}	3.8±0.67	4.04±0.71^{a}
HDL-C (mmol/L)	1.22±0.44	1.20±0.47	1.28±0.42
LDL-C (mmol/L)	2.29±0.52	2.23±0.52	2.37±0.53
NEFA (mmol/L)	2.06±0.61	2.44±0.95**	2.10±0.81

BMI, body mass index; WHR, waist circumference/hip circumference; SBP, systolic blood pressure; DBP, diastolic blood pressure; ABI, ankle brachial index; PWV (average), pulse wave velocity (average); ASP (acylation stimulating protein); C3, complement C3; %ASP/C3, % acylation stimulating protein/complement C3; CRP, C-reactive protein; TG, triglyceride; TC, total cholesterol; HDL-C high density lipoprotein cholesterol; LDL-C, low density lipoprotein cholesterol; NEFA, non-esterified fatty acid. Values are expressed as average ± SEM for each group, where *P<0.05, **P<0.01 and ***P<0.001 for comparison with respect to Han subjects or ^{a}P<0.05, ^{aa}P<0.01 and ^{aaa}P<0.001 with respect to Uygur subjects with each group.

glyceridemia, no hypercholesterolemia, no hypohigh-density lipoprotein cholesterol, no hyperlow-density lipoprotein cholesterol or other chronic diseases. Those whose data were incomplete were excluded. Altogether 331 healthy persons (137 Hans, 114 Uygurs, and 80 Kazaks) completed the survey and examination and were included.

Analysis procedure

Fasting blood samples were assayed for glucose, uric acid, TG, TC, LDL-C, HDL-C, non-esterified fatty acid (NEFA), insulin, C-reactive protein (CRP), acylation stimulating protein (ASP), complement C3. The concentration of fasting glucose, uric acid, TG, TC, LDL-C, and HDL-C was determined via chemical analysis (Dimension AR/AVL Clinical Chemistry System, Newark, NJ, USA) employed by the Clinical Laboratory Department of the First Affiliated Hospital of Xinjiang Medical University. NEFA concentration was measured via a colorimetric enzymatic assay (WAKO Chemicals, Tokyo, Japan). Insulin concentration was determined using I$^{[125I]}$ Insulin Radioimmunoassay Kit (North Biotechnology Research Institute, Beijing, China). CRP and C3 were measured by immunoturbidimetric assay (Beckman Coulter. Inc, Carisbad, USA). ASP concentration was measured using a sandwich ELISA immunoassay, with kits as provided by K Cianflone [21, 22]. Ankle Brachial Index (ABI: right, left and average) and Pulse Wave Velocity (PWV: right, left and average) were measure by fully automatic arteriosclerosis detector (BP-203RFE-II, VP1000, Colin company, Japan) as previously described [17].

Calculation and statistical analyses

Waist-hip ratio (WHR) was calculated as waist circumference (cm)/hip circumference (cm). Body mass index (BMI) was calculated as weight (kg)/height (m^2). The %ASP/C3 was cal-

Table 2. Pearson Correlations with Respect to ASP and C3 within Han, Uygur, and Kazak groups

	Han	Uygur	Kazak	Han	Uygur	Kazak	Han	Uygur	Kazak
R/P	ASP	ASP	ASP	C3	C3	C3	ASP/C3 (%)	ASP/C3 (%)	ASP/C3 (%)
n	137	114	80	137	114	80	137	114	80
Age (yr)	r=0.200 P=0.019	r=0.215 P=0.021	ns	r=0.212 P=0.015	r=0.164 P=0.083	ns	ns	r=0.196 P=0.038	Ns
SEX	ns	r=0.180 P=0.055	ns	ns	ns	ns		r=0.177 P=0.062	Ns
BMI (kg/m^2)	ns	ns	ns	ns	ns	ns	ns	ns	Ns
WHR	ns	ns	ns	ns	ns	ns	ns	ns	Ns
Waist circumference	ns	Ns	ns		r=0.215 P=0.025	ns	ns	ns	ns
Hip circumference	ns	ns	ns		ns	ns	ns	ns	ns
SBP (mmHg)	ns	r=0.215 P=0.022	ns	ns	r=0.1303 P=0.001	ns	ns	r=0.172 P=0.071	ns
DBP (mmHg)	ns	r=0.238 P=0.011	ns	ns	r=0.276 P=0.003	ns	ns	r=0.202 P=0.033	ns
ABI (Average)	ns	ns	ns	ns	ns	r=0.254 P=0.026	ns	ns	ns
ABI (Left)	ns	ns	ns	ns	ns	r=0.233 P=0.042	ns	ns	ns
ABI (Right)	ns	ns	ns	ns	ns	r=0.226 P=0.048	ns	ns	ns
PWV (Average) (cm/s)	ns	ns	ns	ns	r=0.335 P=0.001	ns	ns	ns	ns
PWV (Left) (cm/s)	ns	ns	ns	ns	r=0.322 P=0.001	ns	ns	ns	ns
PWV (Right) (cm/s)	ns	ns	ns	ns	r=0.335 P=0.001	ns	ns	ns	ns
ASP/C3%	r=0.965 P=0.001	ns	ns	ns	ns	ns	ns	ns	ns
CRP (mg/L)	ns	ns	ns		ns	ns	ns	ns	ns
Insulinu (IU/ml)	ns	r=-0.242 P=0.010	ns	ns	ns	ns	ns	r=-0.238 P=0.012	ns
Glucose (mmol/L)	r=0.143 P=0.096	ns	ns	ns	ns	ns	ns	ns	ns
UA (umol/L)	ns	ns	ns	ns	r=0.262 P=0.005	r=0.229 P=0.043	r=-0.177 P=0.042	ns	ns
TG (mmol/L)	ns	r=0.197 P=0.0362	ns	r=0.199 P=0.022	r=0.267 P=0.004	ns	ns	ns	ns
TC (mmol/L)	ns	r=0.203 P=0.031	ns	r=0.153 P=0.079	r=0.244 P=0.009	ns	ns	r=0.192 P=0.043	ns
HDL-C (mmol/L)	ns	ns	ns	ns	ns	r=-0.210 P=0.064	ns	ns	ns
LDL-C (mmol/L)	ns	ns	ns	ns	r=-0.188 P=0.047	ns	ns	ns	ns
NEFA (mEq/L)	ns	ns	ns	r=0.261 P=0.003	ns	r=-0.297 P=0.009	ns	ns	ns

culated as follows: C3 (g/L)×5555=C3 (nmol/L), then [ASP (nmol/L)/C3 (nmol/L)]×100, and the ratio was calculated. All results were expressed as mean ± SEM. Groups were compared by t-tests, one- or two-way ANOVA followed by Dunnett's or linear trend post-hoc test using Prism software (Graphpad Software, San Diego, CA, USA) for graphs and statistical analysis. Relationships between variables in each group were assessed by linear regression analysis using Pearson rank order correlation and predictive models were assessed using stepwise forward multiple regression analysis. Statistical significance was set as $P<0.05$, where NS indicates not significant.

Results

Han, Uygur and Kazak groups were matched based on age, sex and BMI. As seen in **Table 1**, ASP for the Uygurs was significantly less than Han subjects (P=0.0003), while NEFA was increased in Uygurs (P=0.008). Furthermore, C3 and CRP concentrations were significantly higher in Uygurs than in Hans and Kazaks (P<0.001, and P=0.001). By contrast, the Uygur subjects demonstrated the lowest %ASP/C3 as compared to Han and Kazak populations (P<0.001). Kazak subjects had a higher insulin level (P=0.008).

However, concentration of glucose in Han subjects was significantly higher than Uygur subjects (P=0.007). Interesting, with Uygur subjects, the TC level was notably lower than Han and Kazak groups (P=0.0008). In the Han group, the average ABI was significantly different from both Uygur and Kazak groups (P= 0.0003), accompanied with higher DBP (P= 0.0003). No significant difference was found for SBP, PWV, TG, LDL-C, HDL-C and uric acid compared across all groups of Han, Uygur and Kazak.

Table 2 presents correlation analysis between ASP and various parameters. In the Han group, ASP correlates strongly with age, %ASP/C3, and glucose, while in Uygurs there were positive correlations with age, sex, systolic blood pressure (SBP), diastolic blood pressure (DBP), TG and TC, and negative correlations with insulin. Interestingly, there were no significant correlations of ASP with any parameter in Kazaks.

Pearson correlation analysis between C3 and parameters was also performed (**Table 2**). C3 positively correlated with age, TG, TC and NEFA in Hans. Further, there were positive correlations between C3 with age, waist circumference, SBP, DBP, PWV (left, right, average), UA, TG, TC, and negative correlation with LDL-C in Uygur group. For Kazak subjects, C3 was positively correlated with ABI (left, right, average), UA, and negatively correlated with HDL-C and NEFA.

Pearson correlation analysis between %ASP/C3 and parameters demonstrated that there were positive correlations between %ASP/C3 with age, sex, SBP, DBP, TC and negative correlations with insulin in Uygurs, while no correlation was found in Kazaks and only a negative correlation between %ASP/C3 with uric acid in the Han group.

We next examined which parameters significantly predict ASP and C3 concentrations, using stepwise forward multiple regression analysis. A model including insulin, BMI, ABI and uric acid predicted ASP in Hans, and a combination of gender, PWV, and uric acid was the strongest model in Uygurs, while no correlations were identified in Kazaks. C3 concentration in Hans was predicted by a model including CRP, PWV and TC, while DBP, uric acid, TC and LDL-C predicted C3 concentration in Uygurs. CRP and ABI were the strongest model in Kazaks.

Discussion

ASP has previously been shown to be positively correlated with BMI, with increased ASP identified in obesity [10] diabetes and cardiovascular disease [10]. In the present study, both groups are matched for age, BMI and gender distribution and none have hypertension, diabetes, hyperuricemia, or lipid disorders. Notably, an ethnic difference was evident whereby the subjects from the Uygur population had decreased levels of ASP and %ASP/C3, with increased levels of C3, CRP, and NEFA as compared to the Han and Kazak population. While insulin was also increased in Uygurs vs Hans, the Kazaks also had increased insulin.

The present study evaluated markers of cardiovascular disease risk factors such as DBP, ABI and glucose, which were shown to be increased in the Han compared to the Uygur and Kazak populations. However, the Kazak population

had significantly lower hip rate (WHR) and the Uygur population had obviously lowest TC, although still within the normal range.

Although ASP is derived from its precursor C3, and both of them commonly correlate with similar plasma parameters, they rarely correlate strongly with each other [10], suggesting that while production of ASP requires the presence of C3, the production of ASP is likely regulated through other controlling factors [23]. Fujita et al [24] suggested that the lipoprotein chylomicrons and complement Factor H play an important role in the production of ASP. Decreases in ASP were associated with comparable decreases in %ASP/C3, and this may relate to decreased convertase activity [12]. Increased ASP is associated with obesity, diabetes and increased fasting plasma cholesterol, triglyceride, apolipoprotein B and NEFA [10]. The present results indicating that lower ASP was associated with lower glucose, TC and higher NEFA in Uygers may be supportive of this. There are differences among TG, LDL-C, HDL-C. It may be that changes in adipokines occur independently from changes in lipid parameters, according to the ethnic group [25].

CRP is considered as an independent cardiovascular risk factor [26] and has been shown to be correlated with C3 [23]. As the metabolic syndrome is related to a subclinical chronic inflammatory state [27], and a low-level chronic inflammatory state is associated with stimulation of the immune response, increasing inflammatory factors such as C3 may contribute to a higher incidence of metabolic syndrome in the Uygur group.

Overall it would seem that the Uygur population had higher C3, CRP, insulin and NEFA, suggested a disadvantageous metabolic profile as compared to Han and Kazak groups. Surprisingly, the ASP (and %ASP/C3) is not increased, which would have been expected based on the metabolic profile. On the other hand, we speculate that perhaps because ASP does not increase to compensate, there may be a bigger increase in insulin in order to compensate.

ABI is a marker of peripheral arterial disease [28]. It has been suggeted that ABI may improve the accuracy of cardiovascular risk prediction [29]. Reported to be an indicator of arterial stiffness, PWV is an important indicator of arterial elasticity [30]. In the present study, ASP and C3 have been shown to positively correlate to different factors. ABI plays an important role in ASP levels in Hans and C3 levels in Kazaks, while PWV was a predictor of C3 level in Hans and ASP levels in Uygers.

In conclusion, there are differences in ASP, C3, CRP and lipid profiles in healthy adults of Han, Uygur, and Kazak populations. The Uygur population, in particular, have a disadvantageous metabolic profile as compared to Han and Kazak groups.

Acknowledgements

This work was supported by the Xinjiang Science and Technology Program of China (grant number 2013911113).

Disclosure of conflict of interest

None.

Address correspondence to: Yi-Tong Ma, Department of Cardiology, First Affiliated Hospital of Xinjiang Medical University, Urumqi 830011, People's Republic of China. Tel: 86-991-4366169; Fax: 86-991-4366169; 86-991-4363403; E-mail: myt_xj@sina.com

References

[1] Jin Y, Su L, Chang P, Wang H. A study on patterns in the average life expectancies and mortality rates of 56 nationalities in China in 1990. Chin J Popul Sci 1994; 6: 263-279.

[2] Liu C, Ma X, Ma YT, Liu F, Yang YN, H D, Li XM, Huang Y, Chen Y, Chen BD, Xie X. Prevalence on overweight and obesity in Han. Uygur and Hazakh in adults fromXinjiang. Chin J Epidemiol 2010; 31: 1139-43.

[3] Yan WL, Zheng YJ, Wu J, Chen SF, Ti XK, Li L, Liu XR. Ethnic differences in body mass index and prevalence of obesity in school children of Urumqi City, Xinjiang, China. Biomed Environ Sci 2006; 19: 469-73.

[4] Tao Y, Mao X, Xie Z, Ran X, Liu X, Wang Y, Luo X, Hu M, Gen W, Zhang M, Wang T, Ren J, Wufuer H, Li L. The prevalence of type 2 diabetes and hypertension in Uygur and Kazak populations. Cardiovasc Toxicol 2008; 8: 155-9.

[5] Wang L, Tao Y, Xie Z, Ran X, Zhang M, Wang Y, Luo X, Hu M, Gen W, Wufuer H, Li L, Ren J, Mao X. Prevalence of metabolic syndrome, insulin resistance, impaired fasting blood glucose, and dyslipidemia in Uygur and Kazak populations. J Clin Hypertens (Greenwich) 2010; 12: 741-5.

[6] Yan W, Yang X, Zheng Y, Ge D, Zhang Y, Shan Z, Simu H, Sukerobai M, Wang R. The metabolic syndrome in Uygur and Kazak populations. Diabetes Care 2005; 28: 2554-5.
[7] Yang YN, Xie X, Ma YT, Li XM, Fu ZY, Ma X, Huang D, Chen BD, Liu F, Huang Y, Liu C, Zheng YY, Baituola G, Yu ZX, Chen Y. Type 2 diabetes in xinjiang uygur autonomous region, china. PLoS One 2012; 7: e35270.
[8] Li Y, Ma YT, Yu ZX, Yang YN, Li XM, Xie X, Liu F, Chen Y. Epidemiological survey on lipid levels in adults with Han, Uygur and Kazak ethnicities from Xinjiang, China. Chin J Epidemiol 2012; 33: 567-71.
[9] Yan W, Gu D, Yang X, Wu J, Kang L, Zhang L. High-density lipoprotein cholesterol levels increase with age, body mass index, blood pressure and fasting blood glucose in a rural Uygur population in China. J Hypertens 2005; 23: 1985-9.
[10] Cianflone K, Xia Z, Chen LY. Critical review of acylation-stimulating protein physiology in humans and rodents. Biochim Biophys Acta 2003; 1609: 127-143.
[11] Maslowska M, Scantlebury T, Germinario R and Cianflone K. Acute in vitro production of acylation stimulating protein in differentiated human adipocytes. J Lipid Res 1997; 38: 21-31.
[12] Gao Y, Gauvreau D, Cianflone K. Hormone and Pharmaceutical Regulation of ASP Production in 3T3-L1 Adipocytes. J Cell Biochem 2010; 109: 896-905.
[13] Cianflone K, Roncari DAK, Maslowska M, Baldo A, Forden J and Sniderman AD. Adipsin/acylation stimulating protein system in human adipocytes: regulation of triacylglycerol synthesis. Biochemistry 1994; 33: 9489-95.
[14] Baldo A, Sniderman AD, St-Luce S, Avramoglu RK, Maslowska M, Hoang B, Monge JC, Bell A, Mulay S, Cianflone K. The adipsin-acylation stimulating protein system and regulation of intracellular triglyceride synthesis. J Clin Invest 1993; 92: 1543-47.
[15] Yang Y, Lu HL, Zhang J, Yu HY, Wang HW, Zhang MX, Cianflone K. Relation-ships among acylation stimulating protein, adiponectin and complement C3 in lean vs obese type 2 diabetes. Int J Obes (Lond) 2006; 30: 439-46.
[16] Cianflone K, Lu H, Smith J, Yu W, Wang H. Adiponectin, acylation stim-ulating protein and complement C3 are altered in obesity in very young children. Clin Endocrinol (Oxf) 2005; 62: 567-72.
[17] Liu XD, Yuan BB, Buaijiaer. Hasimu. Relationship of atherosclerosis indicators (ba-PWV, ABI and IMT) and coronary heart disease. Journal of Clinical Medicine in Practice 2011; 15: 18-20.
[18] American Diabetes Association Diagnosis and classification of diabetes mellitus. Diabetes Care 2009; 32 Suppl 1: S6218.
[19] 2010 Chinese guidelines for the management of hypertension. Chinese Journal of Cardiology 2011; 39: 390-419.
[20] China's adult dyslipidemia prevention guide. Chinese Journal of Cardiology 2007; 39: 579-614.
[21] Saleh J, Summers LK, Cianflone K, Fielding BA, Sniderman AD, Frayn KN. Coordinated release of acylation stimulating protein (ASP) and triacylglycerol clearance by human adipose tissue in vivo in the post- prandial period. J Lipid Res 1998; 39: 884-91.
[22] Kalant D, Phelis S, Fielding BA, Frayn KN, Cianflone K, Sniderman AD. Increased postprandial fatty acid trapping in subcutaneouss adipose tissue in obese women. J Lipid Res 2000; 41: 1963-8.
[23] Wu Y, Zhang J, Wen Y, Wang H, Zhang M, Cianflone K. Increased acylation-stimulating protein, C-reactive protein, and lipid levels in young women with polycystic ovary syndrome 2009; 91: 213-9.
[24] Fujita T, Fujioka T, Murakami T, Satomura A, Fuke Y, Matsumoto K. Chylomicron accelerates C3 tick-over by regulating the role of Factor H, leading to overproduction of acylation stimulating protein. J Clin Lab Anal 2007; 21: 14-23.
[25] Cianflone K, Lu H, Smith J, Yu W, Wang H. Adiponectin, acylation stimulating protein and complement C3 are altered in obesity in very young children. Clin Endocrinol (Oxf) 2005; 62: 567-72.
[26] Park R, Detrano R, Xiang M, Fu P, Ibrahim Y, LaBree L, Azen S. Combined use of computed tomography coronary calcium scores and C-reactive protein levels in predicting cardiovascular events in nondiabetic individuals. Circulation 2002; 106: 2073-7.
[27] Tamakoshi K, Yatsuya H, Kondo T, Hori Y, Ishikawa M, Zhang H, Murata C, Otsuka R, Zhu S, Toyoshima H. The metabolic syndrome is associated with elevated circulating C-reactive protein in healthy reference range, a systemic low-grade inflammatory state. Int J Obes Relat Metab Disord 2003; 27: 443-9.
[28] Aboyans V, Lacroix P, Ferrieres J, Laskar M. Ancle-brachial index: an essential component for the screening, diagnosis and management of peripheral arterial disease. Arch Mal Coeur Vaiss 2004; 97: 132-8.
[29] Fowkes FG, Murray GD, Butcher I, Heald CL, Lee RJ, Chambless LE, Folsom AR, Hirsch AT, Dramaix M, deBacker G, Wautrecht JC, Kornitzer M, Newman AB, Cushman M, Sutton-Tyrrell K, Fowkes FG, Lee AJ, Price JF, d'Agostino RB, Murabito JM, Norman PE, Jamrozik K, Curb

JD, Masaki KH, Rodríguez BL, Dekker JM, Bouter LM, Heine RJ, Nijpels G, Stehouwer CD, Ferrucci L, McDermott MM, Stoffers HE, Hooi JD, Knottnerus JA, Ogren M, Hedblad B, Witteman JC, Breteler MM, Hunink MG, Hofman A, Criqui MH, Langer RD, Fronek A, Hiatt WR, Hamman R, Resnick HE, Guralnik J, McDermott MM. Ankle Brachial Index Collaboration. Ankle brachial index combined with Framingham Risk Score to predict cardiovascular events and mortality: a meta-analysis. JAMA 2008; 300: 197-208.

[30] Yamashina A, Tomiyama H, Arai T, Hirose K, Koji Y, Hirayama Y, Yamamoto Y, Hori S. Brachialankle pulse wave velocity as marker of arherosclerotic vascular damage and cardiovascular risk. Hypertens Res 2003; 26: 615-23.