Asian Journal of Medical Sciences 8(4): 15-18, 2016
DOI:10.19026/ajms.8. 3419
ISSN: 2040-8765; e-ISSN: 2040-8773

Submitted: August 15, 2016 Accepted: September 14, 2016 Published: December 25, 2016

Research Article

Prevalence of ACTN3 R577X Polymorphism in Chinese University Students

[1]Gao Peng Hua and [2]Zhang Zhi Ming
[1]Department of Physical Education, Northwestern University, Xi'an, Shannxi 710069,
[2]Department of Clinical Laboratory, Xi'an Central Hospital, Xi'an, Shannxi 710003, P.R. China

Abstract: The study on single-nucleotide polymorphism (SNP) of alpha-actinin (ACTN)3 gene was mainly focused on R577X codon (rs1815739), which leads to replacement of an arginine (577R) with a premature stop codon (577X), The ACTN3 R577X polymorphism has been reported to be related to the elite athlete performance, disease and even history of human evolution. The objective of the current study was to analysis genotype and allelic frequencies of ACTN3 R577X in Chinese University Students. We used TaqMan SNP assay for genotyping 638 Chinese Han Nationality University Students. Total of 638 Northwestern University students in this study, of whom 322 were female and 316 were male, The different genotypes were as follow; 32.13% RR (205/638), 51.25% RX(327/638), 16.61% XX (106/638), R allele 0.58(737/1276), X allele 0.42(539/1276). Respectively, 322 female 31.37% RR (101/322), 49.69% RX (160/322), 18.94% XX(61/322),R allele 0.56(362/644), X allele 0.44(282/644). 316 male 32.91% RR (104/316), 52.85% RX(167/316), 14.24% XX (45/316), R allele 0.59(375/632), X allele 0.41(257/632). 638 Northwestern University students in this study were confirmed to have representativeness, It is similar to Iranian population and Caucasian, which is also favors the hypothesis of an adaptive evolutionary history for ACTN3 R577X.

Keywords: ACTN3, Chinese, polymorphism, students

INTRODUCTION

Human athletic ability has a high level heritability, with the development of molecular biology techniques and detection methods, researchers are increasingly concerned with the influence of gene variation on the elite athlete performance and also come to realize the important predictive value of genes. Recently a large number of candidate gene polymorphisms have been studied to investigate potential relations with muscle-related phenotypes in different ethnic, geographic, occupational population (Appell Coriolano and Duarte, 2012). Family of α-actinin proteins consists of four forms protein (ACTN 1-4) which are the major structural elements of the Z-discs in the human skeletal muscle, ACTN1 and ACTN4 assist in cytoskeletal anchoring which belong to non-sarcomeric, while ACTN 2 and ACTN 3 are expressed in muscle fibers. ACTN 3 protein is encoded by ACTN 3 gene which is actin-binding protein and expressed only in type II skeletal muscle fibers (fast-twitch), maintain the integrity of the muscle contraction element and many of the signaling and metabolism of protein interactions (Mills *et al*., 2001). A common nonsense single-nucleotide polymorphism (R577X) in ACTN3 gene, which result in a premature stop codon Ter (X) replacing the Arg (R) at amino acid 577 (rs1815739) (North *et al*., 1999). There are two allele versions in humans, R(functional allele) and X(null allele). It is estimated the more than one billion people have R577X null allele in the world, XX genotype is prevalent in 16-18% of European Caucasian population and 25-29% of the Japanese population (Kikuchi *et al*., 2015), many researchers in the field of sports science are concerned about the relation between the lack of ACTN3 in the human fast muscle fiber and performance of sports (Papadimitriou *et al*., 2016). Although many studies have shown that ACTN3 gene polymorphism is associated with the performance of elite endurance and power athletes (Mikami *et al*., 2014), there are many studies reported the opposite results (Ruiz *et al*., 2013). In addition, ACTN3 gene polymorphism has been discovered in the cardiometabolic health (Deschamps *et al*., 2015), spinal cord injury (Broos *et al*., 2012) and idiopathic Inflammatory Myopathies (IIMs) (Sandoval-García *et al*., 2012), however the data of ACTN3 R577X polymorphism in Chinese University students remains unknown, so the aim of this study was to investigate the prevalence of the allele in Chinese University students.

Corresponding Author: Zhang Zhi Ming, Department of Clinical Laboratory, Xi'an Central Hospital, Xi'an, Shannxi 710003, P.R. China

MATERIALS AND METHODS

In this study, Subjects were 638 from Northwestern University students (322 female, 316 male; age 20.62±2.74 years), all the subjects were excluded patients with acute or chronic liver, kidney disease, cardiovascular, endocrine or metabolic disorders patients. Physical activity is normal without any professional training, physical examination qualified and no family history of sports training. All the subjects were from Shaanxi provinces in Northwest China descent for ≥3 generations. The experimental procedures were been performed with the approval and Ethics Committee of Research Centre in Sports, Department of Physical Education of Northwestern University, approved all procedures.

Genotyping: During fall 2015, Peripheral venous blood samples were collected in 2 mL EDTA-K2 anticoagulant tube at -20°C until DNA extraction. Genomic DNA was extracted from blood samples during the years 2015-2016 and genotyping was performed in Clinical Laboratory of Xi'an Central Hospital, China. ACTN3 R577X (rs1815739) genotyping methods were carried out by using the TaqMan SNP Genotyping Assay (Applied Biosystems, Foster City, California, USA) (Schadock *et al*., 2015). PCR reaction system as follows: genomic DNA 2 uL, TaqMan Universal PCR amplified premixed reagent (Applied Biosystems, Foster City, California, USA) 13.75 uL, primers and probe (TakaRa, Dalian, China) per 0.5 uL. Finally, the complement of double distilled water to the total 25 uL reaction volume. Reaction parameters: 1 cycles of 50°C for 2 min, 95°C for 10 min, 40 cycles of 92°C for 15 s and 60°C for 1 min, the fluorescence detection period of 60°C 1 min. PCR reactions and genotype analysis were run on ABI 7300 instrument.

Statistical analysis: The anthropometric measures are presented as mean and SEM. Genotypes and alleles frequencies were calculated by direct counting method, Hardy-Weinberg equilibrium was used chi-square test. Statistical significance was accepted at p value of less than 0.05. All statistical analyses were performed using the SPSS 13.0 software for windows.

RESULTS AND DISCUSSION

A total of 638 Northwestern University students in this study, of whom 322 (322/638, 50.5%) were female and (316/638, 49.5%) were male, All subjects were Han Nationality, The ACTN3 R577X polymorphism's distribution from 322 female University Students was met the condition of HWE ($F = 0.028$, $df = 1$, $p>0.05$) and 316 male University Students was met the condition of HWE ($F = 2.86$, $df = 1$, $p>0.05$). The total of 638 University students was also met the condition of HWE ($F = 1.62$, $df = 1$, $p>0.05$). Therefore, the polymorphism distribution of 322 female and 316 male University Students were confirmed to have representativeness. Which is shown in Table 1.

It is well-known that skeletal muscle was made up of individual muscle fibers, muscle fibers are classified into slow twitch fibers (Type I fibers) and fast twitch fibers (Type II fibers). Type I fibers are more efficient at using oxygen to generate ATP to participate in the need for endurance exercise, such as marathon and bicycle for hours. Whereas Type II fibers are mainly involved in the need of high force and low endurance, directly to create energy via anaerobic metabolism, such as sprint (Vincent *et al*., 2007). Fast fibers produce ACTN3, which reflects the body's ability to produce fast power. Researchers in many fields of science are very concerned about whether ACTN3 gene polymorphism affect movement ability and quality or not, especially the quality of the explosive force. A study by Eynon *et al*. (2009) showed that the proportion of group velocity athletes ACTN3 R577X polymorphism RR genotype were found to be significantly higher than that of the endurance athlete group and the control group and endurance athletes of group in the XX genotype proportion was even higher. In addition, it was found that the proportion of R allele was higher in top level athletes according to the level of achievement points to the top level and the national level athletes, So they think that the R allele of R577X ACTN3 polymorphism was associated with the velocity and quality of explosive force. These findings were also validated in others studies Mikami *et al*. (2014). In contrast, there were quite a number of studies which had reported the opposite result. A study by Ruiz *et al*. (2011) reported no significant influence of the ACTN3 R577X polymorphism on explosive leg muscle power

Table 1: Genotypes of ACTN3 genotype and alleles in Chinese university students

	Genotype			Allele frequency	
	RR	RX	XX	R	X
Female	101/322	160/322	61/322	362/644	282/644
	31.37%	49.69%	18.94%	0.56	0.44
Male	104/316	167/316	45/316	375/632	257/632
	32.91%	52.85%	14.24%	0.59	0.41
Totle	205/638	327/638	106/638	737/1276	539/1276
	32.13%	51.25%	16.61%	0.58	0.42

in elite volleyball player. Similar results had been obtained from the other study (Ruiz *et al*., 2013). Recently a many of studies have described association ACTN 3 R577X polymorphism with the diseases (Broos *et al*., 2012). A study by Amorim *et al*. (2015) suggested that the functional ACTN3 R577X polymorphism might have evolved due to selection in Eurasian populations, that The R577X ACTN3 allele frequency shows a general trend of increase with distance from Africa (577X allele frequencies lowest: 0.093), reaching its highest frequencies in the Americas continent (577 X allele frequencies highest: 0.764).

Currently an ideal sample for studies of population genetics generally need more than 500 people, there are mostly about 150 people due to various reasons (which is the minimum). The results of the above study may be related to the sample size, population and ethnic differences. So it is very important to analysis genotype and allelic frequencies of ACTN3 R577X in Chinese University Students. Subjects were selected from Han nationality students of Northwestern University, age span less ideal reference population, Most important all the subjects were from Shaanxi provinces in Northwest China descent for ≥3 generations and without any professional sports training.

CONCLUSION

In summary, we investigated that 638 Northwestern University students in this study were confirmed to have representativeness under the conditions that the genotype and allele frequencies attained the Hard-Weinberg equilibrium, The R allelic distributions was 0.58 and X allelic distributions was 0.42.It is similar to Iranian population and Caucasian, which is also favors the hypothesis of an adaptive evolutionary history for ACTN3 R577X (Fattahi and Najmabadi, 2012).

CONFLICT OF INTEREST

No conflict of interest exits in the submission of this manuscript and manuscript is approved by all authors for publication.

REFERENCES

Amorim, C.E.G., V. Acuña-Alonzo, F.M. Salzano, M.C. Bortolini and T. Hünemeier, 2015. Differing evolutionary histories of the ACTN3*R577X polymorphism among the major human geographic groups. PLoS One, 10(2): e0115449.

Appell Coriolano, H.J. and J.A. Duarte, 2012. Studies on gene polymorphisms in sports fancy fashion or important field of research? Int. J. Sports Med., 33(6): 419-420.

Broos, S., L. Malisoux, D. Theisen, M. Francaux, L. Deldicque and M.A. Thomis, 2012. Role of alpha-actinin-3 in contractile properties of human single muscle fibers: A case series study in paraplegics. PLoS One, 7(11): e49281.

Deschamps, C.L., K.E. Connors, M.S. Klein, V.L. Johnsen, J. Shearer, H.J. Vogel, J.M. Devaney, H. Gordish-Dressman, G.M. Many, W. Barfield, E.P. Hoffman, W.E. Kraus and D.S. Hittel, 2015. The ACTN3 R577X polymorphism is associated with cardiometabolic fitness in healthy young adults. PLoS One, 10(6): e0130644.

Eynon, N., J.A. Duarte, J. Oliveira, M. Sagiv, C. Yamin, Y. Meckel, M. Sagiv and E. Goldhammer, 2009. ACTN3 R577X polymorphism and Israeli top-level athletes. Int. J. Sports Med., 30(9): 695-698.

Fattahi, Z. and H. Najmabadi, 2012. Prevalence of ACTN3 (the athlete gene) R577X polymorphism in Iranian population. Iran Red Crescent Me., 14(10): 617-622.

Kikuchi, N., S. Yoshida, S.K. Min, K. Lee, M. Sakamaki-Sunaga, T. Okamoto and K. Nakazato, 2015. The ACTN3 R577X genotype is associated with muscle function in a Japanese population. Appl. Physiol. Nutr. Me., 40(4): 316-322.

Mikami, E., N. Fuku, H. Murakami, H. Tsuchie, H. Takahashi, N. Ohiwa, H. Tanaka, Y.P. Pitsiladis, M. Higuchi, M. Miyachi, T. Kawahara and M. Tanaka, 2014. ACTN3 R577X genotype is associated with sprinting in elite Japanese athletes. Int. J. Sports Med., 35(2): 172-177.

Mills, M., N. Yang, R. Weinberger, D.L. Vander Woude, A.H. Beggs, S. Easteal and K. North, 2001. Differential expression of the actin-binding proteins, alpha-actinin-2 and -3, in different species: Implications for the evolution of functional redundancy. Hum. Mol. Genet., 10: 1335-1346.

North, K.N., N. Yang, D. Wattanasirichaigoon, M. Mills, S. Easteal and A.H. Beggs, 1999. A common nonsense mutation results in alpha-actinin-3 deficiency in the general population. Nat. Genet., 21(4): 353-354.

Papadimitriou, I.D., A. Lucia, Y.P. Pitsiladis, V.P. Pushkarev, D.A. Dyatlov, E.F. Orekhov, G.G. Artioli, J.P.L.F. Guilherme, A.H. Lancha Jr, V. Ginevičienė, P. Cieszczyk, A. Maciejewska-Karlowska, M. Sawczuk *et al*., 2016. ACTN3 R577X and ACE I/D gene variants influence performance in elite sprinters: A multi-cohort study. BMC Genomics, 17: 285.

Ruiz, J.R., C. Santiago, T. Yvert, C. Muniesa, G. Díaz-Ureña, N. Bekendam, C. Fiuza-Luces, F. Gómez-Gallego, P. Femia and A. Lucia, 2013. ACTN3 genotype in Spanish elite swimmers: No "heterozygous advantage". Scand. J. Med. Sci. Spor., 23(3): e162-e167.

Ruiz, J.R., M. Fernández del Valle, Z. Verde, I. Díez-Vega, C. Santiago, T. Yvert, G. Rodríguez-Romo, F. Gómez-Gallego, J.J. Molina and A. Lucia, 2011. ACTN3 R577X polymorphism does not influence explosive leg muscle power in elite volleyball players. Scand. J. Med. Sci. Spor., 21(6): e34-e41.

Sandoval-García, F., M.H. Petri, M.A. Saavedra, C.V. Cruz-Reyes, L.J. Jara-Quezada, I.P. Dávalos-Rodríguez, M. Salazar-Páramo, J.I. Gámez-Nava, L. González-López, T. García-Iglesias, E.G. Corona-Sánchez, S. Zavaleta-Muñiz, R. Vargas-Ramírez, M. Vázquez-Del Mercado and B.T. Martín-Márquez, 2012. The ACTN3 R577X polymorphism is associated with inflammatory myopathies in a Mexican population. Scand. J. Rheumatol., 41(5): 396-400.

Schadock, I., A. Schneider, E.D. Silva, M.R. Buchweitz, M.N. Correa, J.B. Pesquero, E.J. Paredes-Gamero, R.C. Araujo and C.C. Barros, 2015. Simple method to genotype the ACTN3 r577x polymorphism. Genet. Test. Mol. Bioma., 19(5): 253-257.

Vincent, B., K. De Bock, M. Ramaekers, E. Van den Eede, M. Van Leemputte, P. Hespel and M.A. Thomis, 2007. ACTN3 (R577X) genotype is associated with fiber type distribution. Physiol. Genomics, 32(1): 58-63.