Physical Activity and Vascular Dilation Function in Healthy Middle-aged Individuals

LIANG Qi[1] LIU Donghong[2] WANG Yuling[1] SUN Bing[2] LIN Fengqiao[2]
GAN Hanjing[3] WU Guifu[2] WANG Lichun[2] MA Hong[2]

Abstract **Objective:** Vascular dilation dysfunction has been linked with risk of cardiovascular disease. This study was undertaken to investigate the relationship between physical activity and vascular dilation function in healthy middle-aged adults to help explaining the effect of physical activity on preventing cardiovascular disease. **Method:** We recruited 91 healthy middle-aged adults to complete a self-report 7-day physical activity recall questionnaire and an exam of brachial artery flow-mediated dilation(FMD) and Nitroglycerin-mediated dilation (NMD) detected by ultrasound. The relationship between physical activity level (PAL) and FMD and NMD were explored. **Result:** Physical activity showed a significant and positive relationship with the brachial artery FMD, even after adjustment for possible confounding factors (r=0.363, P<0.01). The group of high physical activity level had the highest FMD. The means of FMD (%) in low, moderate and high PAL groups were respectively 8.70%±3.93%, 9.01%±3.22% and 12.38±5.67% with significant difference between individuals of low and high PAL and between moderate and high PAL group(P<0.01). The means of NMD (%) is 25.13%±6.52%, 24.38%±5.44% and 29.50%±7.25% respectively (P> 0.05) and there was no significant difference among three groups. There was no positive relation between PAL and FMD in premenopausal females but in men and postmenopausal females. Although individuals of high PAL have the best FMD, the moderate PAL can also retard FMD decrease with ageing. **Conclusion:** Maintaining high physical activity level can enhance endothelial-dependent vascular dilation, and moderate or high physical activity level can prevent endothelial-dependent vascular dilation declining with aging, which may contribute to decrease risk of cardiovascular disease in healthy middle-aged adults.

Key words physical activity; flow-mediated dilation;, nitroglycerin-mediated dilation

Regular physical activity is effective to prevent coronary heart disease (CHD). The morbidity of CHD decreases when the level of physical activity increases[1]. Previous researches suggest that the effect of physical activity prevention of CHD is partly due to enhanced function of vascular endothelium[2—6]. While some researchers indicated that CHD is associated with endothelium independent vascular dilation[7]. But, the different effects on endothelium-dependent dilation and non-enhanced endothelium-dependent dilation of different levels of physical activity were not fully understood. This present cross-sectional study was undertaken to investigate the relationship between different physical activity level and endothelial dependent or independent vascular dilation in healthy meddle-aged individuals.

1 METHODS

1.1 Participants

We recruited 91 men and women (aged 40—60 years) from Guangzhou Winter Swimming Association and Society. All the volunteers were Han Nationality. Baseline evaluations included standardized physical examination, diagnostic testing, laboratory evaluation, and questionnaires on health status, medical history, lifestyle habits, and cardiovascular risk factors. The exclusive criteria were: any history of high blood pressure, coronary heart disease, cerebral vascular disease, peripheral vascular disease, diabetes mellitus, myocardial disease, chronic heart failure, chronic liver and kidney disease, cancer and any acute or chronic disease which did not permit exercise. One participant was diagnosed idiopathic thrombocytopenic purpura, and the other asthma, but the symptom had relieved and the participants took no therapeutic medication so that we still recruit them. All participants were provided with informed consent.

1.2 Measurements

1.2.1 Assessment of physical activity:The physical activity level (PAL) of all participants was assessed via the Chinese version of Seven-day Physical Activity Recall Items (7D-PAR) which was translated from the universal physical activity questionnaire 7D-PAR [8]. The reliability and validity of Chinese version were tested and proved to be applicable

1 Department of Rehabilitation Medicine, First Affiliated Hospital of Sun Yat-sen University, Guangzhou, China, 510080

2 Department of Cardiovascular Medicine, First Affiliated Hospital of Sun Yat-sen University.

3 Department of Ultrasonography, People's Hospital of Shenzhen City.

with the physical activity situation in Chinese population. The participants were asked to recall and estimate the number of hours spent in sleep, moderate, hard, and very hard activity during the past 7 days, including Saturday and Sunday. The remaining time represented light activity. The work metabolic rate/rest metabolic rate ratio (MET) values were assigned to the various activities. Sleep is estimated as 1 MET, light activity as 1.5 METs, moderate activity as 4 METs, hard activity as 6 METs and very hard activity as 10 METs. MET values are multiplied by the hours spent in each of the five categories and the products were added to give MET value per day. The MET value of total seven days were added and averaged to get the average MET value per day. If the average MET value per day was lower than 33.3 METs, it was defined as low physical activity level. If the value between 33.4—35.0METs then was moderate physical activity level, and higher than 35METs was high physical activity level.

1.2.2 Assessment of flow-mediated dilation (FMD) and Nitroglycerin-mediated dilation (NMD): All studies were performed in the morning in a quiet room with a temperature of approximately 20—25℃ by the same experienced sonographer of the department of ultrasound. Endothelium-dependent and -independent vasodilator function was assessed as previously described [9]. Briefly, subjects lay supine on a bed and were asked to rest for at least 10 min. Then, the right brachial artery was visualized to get baseline diameter, using a high-resolution ultrasound with a 7.5MHz linear array transducer (PHILIP ALT 5000, USA). Then a pressure cuff applied on the forearm was inflated at 240mmHg for 4—5min. Blood flow was measured during the 15s after cuff release, and arterial image acquisitions for diameter measurements were performed between 15s and 120s after cuff deflation. After at least 10min of rest, 0.5mg of nitroglycerin was given sublingually. Blood flow and images for arterial diameter were recorded after 3—4min. The response of the vessel diameter to reactive hyperemia and nitroglycerin was expressed as percent change relative to the diameter immediately before cuff inflation and to the diameter immediately before drug administration, as FMD(%) and NMD(%) respectively.

1.3 Statistical analysis

Physical activity categories were assessed as ordinal variables for evaluation of differences in baseline characteristics with linear. Descriptive data are presented as mean ± SD. Baseline data were compared by the Student *t* test between two groups and by ANOVA among three groups for continuous variables or by the χ^2 test Fisher exact test for categorical variables. Categorical data were analyzed by the chi-square statistics. The Pearson correlation coefficient was used to evaluate associations. Stepwise Multi Regression Analysis was used to explore the statistical relationships between physical activity level and vascular reaction. Differences were considered significant at $P<0.05$. Analyses were performed using SPSS version 16 statistical package (SPSS Inc., Chicago, IL, USA). $P<0.05$ denotes statistical significance between the groups.

2 RESULTS

2.1 Subjects

The group characteristics according to PAL of ninety-one participants are presented in Table 1. Participants in low PLA group had little physical activity of moderate or high intensity. Most participants in moderate PLA usually attended moderate-intensity swimming less than 60min/d. Participants in high PLA attended more activities such as walking, jogging, swimming, climbing and cycling, and total exercise time reached to more than 60min.

Table 1 Characteristics of different PAL groups

	Low PAL (n=41)	Moderate PAL (n=19)	High PAL (n=31)	*P*
Age(years)	50±4.2	50.7±3.8	49.8±4.9	>0.05
Male	24	10	12	>0.05
Smoking habit	13	1	4	<0.05
BMI(kg/m^2)	23.7±2.53	22.8±2.64	22.4±1.91	<0.05

2.2 The relationship between the brachial artery FMD, NMD and average MET value per day

The brachial artery FMD was positively associated with average MET value per day,r=0.363,P<0.01,shown in Figure 1.The NMD had no statistically significant relationship with average MET value per day, r=0.185, P>0.05.

2.3 The brachial artery FMD and NMD compared in different PAL groups and subgroups

2.3.1 The brachial artery FMD was 8.70%±3.93%, 9.01%±3.22% and 12.38%±5.67% respectively in low, moderate and high PAL groups (P<0.01). The difference was statistically significant between high PAL groups and low or moderate PAL groups (both P<0.01), but not between low and moderate PAL groups. The results were shown in Table 2 and Figure 2.

2.3.2 The brachial artery FMD and NMD in different PAL groups in males were shown in Table 2. To evaluate the relationship between PAL and FMD, we used Stepwise Multi Regression Analysis to adjust the effects of covariates such as smoking status, age and BMI and found out that the PAL was the only statistically significant factor for the brachial artery FMD in males. The linear equation was FMD=5.679+1.522×PAL, P=0.05.

The FMD and NMD in different PAL groups in females were shown in Table 2 too. The brachial artery FMD and NMD in female was 10.93%±4.30% and 27.20%±7.36% re-

spectively, compared with 8.16%±3.89% (FMD) and 23.84% ±6.21%(NMD) in males, the difference was statistically significant(P<0.01,0.05,respectively). However the difference disappeared when compared between menopausal females and males. In postmenopausal females, there was positive relationship between average MET value per day and the FMD, r=0.936, P<0.01. The FMD in high PAL group was higher than that in moderate and low PAL groups, but no significant difference between moderate and low PAL groups. The data were presented in Table 2.

2.4 The relationship between age and the brachial artery FMD and NMD in different PAL groups

In low PAL group, the brachial artery FMD was associated negatively with age, r=–0.516, P<0.01. The FMD declined with aging. But in moderate and high PAL groups, the negative relationship disappeared. The brachial artery NMD had no relationship with age in all PAL groups.

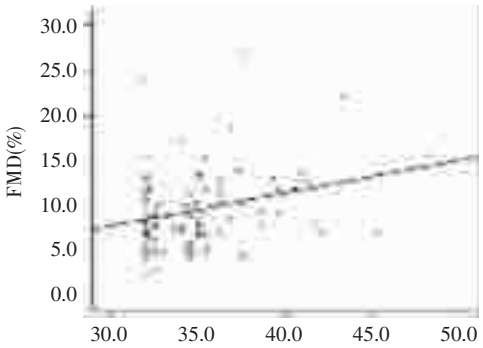

Fig. 1 The Pearson relationship between the brachial artery FMD and average MET value per day

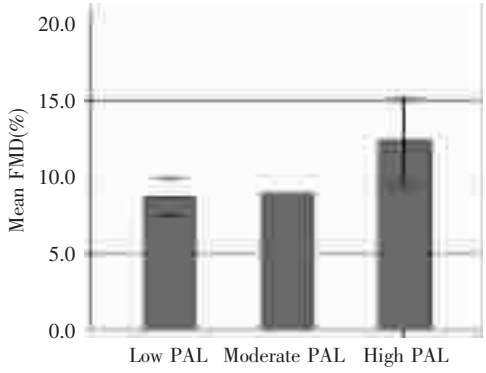

Fig. 2 The mean of brachial artery FMD comparison between different PAL groups

3 DISCUSSION

The purpose of this cross–sectional research is to explore the effect of daily physical activity on vascular dilation in healthy middle–aged adults. It is found that the FMD was positively associated with daily average total METs and the participants in high PAL groups had the highest FMD, but the difference between moderate and low PAL groups was not statistically significant. The results suggest

Table 2 Comparing the mean of brachial artery FMD and NMD in different PAL groups ($\bar{x}\pm s$)

Group/PAL	FMD(%)	NMD(%)
Whole Subjects		
Low PAL	8.70±3.93	25.13±6.52
Moderate PAL	9.01±3.22	24.38±5.44
High PAL	12.38±5.67②	29.50±7.25
Males		
Low PAL	7.42±2.49	23.83±4.89
Moderate PAL	8.03±2.97	24.88±6.17
High PAL	10.99±7.58①	24.62±5.14
Postmenopausal Females		
Low PAL	7.71±3.23	23.17±7.12
Moderate PAL	9.85±5.21	28.51±7.6
High PAL	12.45±4.76①	25.86±7.01
Premenopausal Females		
Low PAL	13.55±4.70	31.22±7.29
Moderate PAL	9.95±1.13	26.38±4.62
High PAL	11.48±3.73	27.13±8.50

Mean values ± SD represent for the percentage of FMD and NMD in different PAL groups. PAL: physical activity level; FMD: flow–mediated dilation; NMD: Nitroglycerin –mediated dilation. ① Significance level at P<0.05, ② significance level at P<0.01.

that physical activities might have positive effects on the endothelial–dependent vascular dilation in healthy middle–aged adults but this effect be determined by the amount of physical activity. The basic endothelial–dependent vascular dilation of the healthy participants in this study was rather good even the brachial artery FMD of low PAL groups was nearly normal. The previous studies had revealed that moderate exercise had little effect on increasing function of normal endothelium[10—13]. And the type of exercise may have different effect on the brachial aretry FMD. In this study, the participants in high PAL groups attended jogging or climbing mountain or cycling except swimming, but the most in moderate PAL groups only took part in moderate–intensity swimming. A recent study has found that cyclist showed higher FMD in the brachial artery and greater peak muscle perfusion and conductance in the non–exercising muscles, whereas swimmers presented only enhanced FMD in the superficial femoral artery [14]. The different effects of different type of exercise on different vascular FMD might partly explain our results.

The results of this study suggested that moderate PAL had little effect on increasing nearly normal endothelial–dependent vascular dilation in healthy middle–aged people. However the vascular dilation is determined not only by endothelia–dependent dilation but also by artery compliance. A study [15] in young adults revealed that artery compliance was significantly lower in sedentary subjects than in physically active subjects, whereas flow–mediated dilation was not distinctive between the groups. We suggested that the effect of physical activity on vascular dilation of healthy adults might be represented in enhancing vascular compliance first, and then in increasing endothelial–

dependent dilation when amount of physical activity increased.

The previous study found that postmenopausal women had similar decreased FMD to males but the younger women had the higher FMD due to higher female hormone [16]. Similarly, FMD of premenopausal women was higher than that of male and postmenopausal women, and was not associated with PAL in this study. This suggests that the vascular dilation of premenopausal women is rather good and physical activity had little effect on increasing it. On the contrary, the FMD of postmenopausal women was similar to males. But the premenopausal women of high PAL group had higher FMD than moderate and low PAL. The results suggest that maintaining high PAL might contribute to higher vascular dilation in postmenopausal women. This population should be encouraged to attend more physical activities and exercises.

Aging is the major risk factor of atherosclerosis disease and is associated with vascular remodeling and deceased vascular endothelial function. Exercise can retard the endothelial dysfunction accompanied by aging [17—21]. We found that the negative relationship between age and FMD existed only in low PAL group. This result suggests that moderate and high PAL might have protective effect on declining of endothelial dilation due to aging.

Most guidelines of physical activity and public health recommended that healthy adults should attend minimum 30 minutes moderate-intensity aerobic physical activity on five days each week to promote and maintain health. The amount of recommended exercise is equivalent to the moderate PAL in our study. Although the moderate PAL had little effect on increasing the normal FMD, but it could protect the declining of FMD accompanied by aging in our study. The previous studies have revealed that morbidity of coronary heart disease was negatively associated with physical activity level [22—23]. More physical activity is related to less coronary heart disease. And the lowest protective amount of physical activity is still argued [24]. Further studies are needed to explore the more suitable amount of physical activity to protect cardiovascular disease in specific population.

The brachial NMD represents the endothelial-independent vascular dilation and is an indication of the function of vascular smooth muscles. Some studies indicated that NMD was related to atherosclerosis and so that protection of NMD decline was one of the purposes of interventions [7, 25]. One recent study revealed that the long-term trained adults had improved NMD than sedentary controls[14]. But in our study, the brachial artery NMD of the whole participants are normal and we found no further enhancing effect of physical activity on normal NMD of healthy adults.

4 CONCLUSIONS

Physical activity level is positively associated with the endothelial-dependent vascular dilation in healthy middle-aged adults. To get a higher vascular dilation in males and post-menopausal females, a high PAL is needed. Both moderate and high PAL can protect endothelial-dependent vascular dilation declining due to aging. Active physical activity can increase vascular dilation function, which may contribute to decrease risk of cardiovascular disease in middle-aged adults.

REFERENCES

[1] Thompson PD, Buchner D, Ileana L P, et al. Exercise and physical activity in the prevention and treatment of atherosclerotic cardiovascular disease [J]. Circulation, 2003, 107: 3109—3116.

[2] Clarkson P, Montgomery HE, Mullen MJ, et al. Exercise training enhances endothelial function in young men [J]. J Am Coll Cardiol, 1999, 33 (5):1379—85.

[3] Christopher A, DeSouza, Linda F, et al. Regular Aerobic exercise prevents and restores age-related declines in endothelium-dependent vasodilation in healthy men [J]. Circulation, 2000, 102: 1351—1357.

[4] Yukihito Higashi, Shota Sasaki, Satoshi Kurisu, et al. Regular Aerobic Exercise Augments Endothelium-Dependent Vascular Relaxation in Normotensive As Well As Hypertensive Subjects: Role of Endothelium-Derived Nitric Oxide [J]. Circulation, 1999, 100: 1194—1202.

[5] Hambrecht R, Wolf A, Gielen S, et al. Effect of exercise on coronary endothelial function in patients with coronary artery disease[J]. N Engl J Med, 2000 17, 342 (7):454—60.

[6] Gielen S, Hambrecht S. Exercise training in coronary artery disease and coronary vasomotion[J]. Circulation, 2001, 103: 1—6.

[7] Adams MR, Robinson J, McCredie R, et al. Smooth muscle dysfunction occurs independently of impaired endothelium-dependent dilation in adults at risk of atherosclerosis [J]. J Am Coll Cardiol, 1998, 32 (1):123—7.

[8] Sallis JF, Haskell WL, Wood PD, et al. Physical activity assessment methodology in the five-city project [J]. American Journal of Epidemiology, 1985, 121 (1):91—106.

[9] Corretti MC, Anderson TJ, Benjamin EJ, et al. Guidelines for the ultrasound assessment of endothelial-dependent flow-mediated vasodilation of the brachial artery: a report of the International Brachial Artery Reactivity Task Force [J]. J Am Coll Cardiol, 2002 16, 39 (2):257—265.

[10] Green DJ, Cable NT, Fox C, et al. Modification of forearm resistance vessels by exercise training in young men[J]. J Appl Physiol, 1994, 77, 1829—1833.

[11] Kingwell BA, Sherrard B, Jennings GL, et al. Four weeks of

cycle training increases basal production of nitric oxide from the forearm[J]. Am J Physiol, 1997, 272, H1070—H1077.

[12] Maiorana A, O′Driscoll G, Dembo L, et al. Exercise training, vascular function, and functional capacity in middle-aged subjects[J]. Med Sci Sports Exerc, 2001,33(12):2022—2028.

[13] Taddei S, Galetta F, Virdis A, et al. Physical activity prevents age-related impairment in nitric oxide availability in elderly athletes[J]. Circulation, 2000, 101, 2896—2901.

[14] Walther G, Nottin S, Karpoff L, et al. Flow-mediated dilation and exercise-induced hyperaemia in highly trained athletes: comparison of the upper and lower limb vasculature [J]. Acta Physiol (Oxf), 2008, 193(2):139—50.

[15] McGavock JM,Anderson TJ, Lewanczuk RZ. Sedentary lifestyle and antecedents of cardiovascular disease in young adults[J]. Am J Hypertens, 2006, 19(7):701—7.

[16] Jensen-Urstad K, Johansson J. Gender difference in age-related changes in vascular function [J]. J Intern Med, 2001, 250(1):29—36.

[17] Brandes RP, Fleming I, Busse R. Endothelial aging [J]. Cardiovasc Res, 2005, 66(2):286—94.

[18] Tanabe T, Maeda S, Miyauchi T, et al. Exercise training improves ageing-induced decrease in eNOS expression of the aorta[J]. Acta Physiol Scand, 2003, 178(1):3—10.

[19] Franzoni F, Galetta F, Morizzo C, et al. Effects of age and physical fitness on microcirculatory function [J]. Clin Sci (Lond), 2004, 106(3):329—35.

[20] Franzoni F, Ghiadoni L, Galetta F, et al. Physical activity, plasma antioxidant capacity, and endothelium-dependent vasodilation in young and older men [J]. Am J Hypertens, 2005, 18(4 Pt 1):510—516.

[21] Taddei S, Galetta F, Virdis A, et al. Physical activity prevents age-related impairment in nitric oxide availability in elderly athletes[J]. Circulation, 2000, 101(25): 2896—2901.

[22] Zhang X, Xie GQ, Zhang LF, et al. Study on the baseline physical activity and the risk of ischemic cardiovascular diseases [J]. Zhonghua Liu Xing Bing Xue Za Zhi, 2006, 27: 930—933.

[23] I-Min Lee,Howard D,Yuko Oguma,et al. Relative intensity of physical activity and risk of coronary heart disease [J]. Circulation, 2003, 107:1110.

[24] Kesaniemi YA, Danforth E Jr, Jensen MD, et al. Dose-response issues concerning physical activity and health: an evidence-based symposium [J]. Med Sci Sports Exerc, 2001, 33 (suppl): S351—S358.

[25] Järvisalo MJ, Lehtimäki T, Raitakari OT. Determinants of arterial nitrate-mediated dilatation in children: role of oxidized low-density lipoprotein, endothelial function, and carotid intima-media thickness [J]. Circulation, 2004, 109: 2885—2889.

国家继续医学教育项目关于举办全国言语障碍、吞咽困难培训班通知

在美国加州嘉惠尔医院语言治疗部主任欧阳来祥(美籍华人)教授协助下,北京天坛医院神经内科已成功举办三期的言语障碍、吞咽培训班,参加的学员从第一期的 20 多人,发展到第四期的 200 多人,学员不仅学到了言语障碍、吞咽困难的基本知识和康复手段,而且了解了言语障碍、吞咽困难的国内外发展动向。为继续满足各单位培训康复人才的需要,2009 年 6 月 22—25 日北京天坛医院神经内科将继续举办为期 5 天的言语障碍、吞咽困难培训班。本培训班除了将由北京天坛医院神经内科从事多年言语障碍、吞咽困难的专家讲课外,还将继续请从事言语治疗工作 20 多年的欧阳来祥(美籍华人)教授讲授相关的内容。培训班注重理论与实践相结合,突出动手操作能力的培训,主要教授言语障碍、吞咽困难的评价与治疗,并针对具体患者,示范训练方法。本培训班为全国继续医学教育项目,培训班结束后,授予继续教育学分 10 分。

教学目的:学习言语障碍、吞咽困难的理论与训练技术,重在学员的实际训练能力的提高。

教学方法:理论教学、示范、实习、讨论相结合。

收费标准:学费 1000 元。资料费 300 元(包括授课示范光盘 2 套),食宿由培训班同一安排,费用自理。

报到时间:2009 年 6 月 21 日早 8:00—20:00

报到地点:北京天坛医院院内拓新宾馆

联系方式:北京市崇文区天坛西里 6 号北京天坛医院神经内科,张玉梅(13691404106),周筠(010-86879887)

E-mail: zhangyumei95@yahoo.com.cn