Journal of Community Medicine & Public Health
Kita T and Kitamura K. J Community Med Public Health 6: 241.
www.doi.org/10.29011/2577-2228.100241
www.gavinpublishers.com

OPEN ACCESS

GAVIN PUBLISHERS

Research Article

The Decreasing Trends of Pulse Wave Velocity and Ankle- Brachial Pressure Index in Japanese Medical Students: A Sixteen-Year Study

Toshihiro Kita*, Kazuo Kitamura

Department of Projects Research, Frontier Science Research Center, University of Miyazaki, Miyazaki, Japan

***Corresponding author:** Toshihiro Kita, Department of Projects Research, Frontier Science Research Center, University of Miyazaki, 5200 Kihara, Miyazaki, Miyazaki 889-1692, Japan

Citation: Kita T, Kitamura K (2022) The Decreasing Trends of Pulse Wave Velocity and Ankle- Brachial Pressure Index in Japanese Medical Students: A Sixteen-Year Study. J Community Med Public Health 6: 241. DOI: 10.29011/2577-2228.100241

Received Date: 24 March, 2022; **Accepted Date:** 01 April, 2022; **Published Date:** 06 April, 2022

Abstract

Background: Atherosclerosis of the artery begins in the early phase of life. Environmental factors have a strong impact on the progression of atherosclerosis, and thus, the recent rise in health awareness may have a positive influence on the condition of arteries. **Method:** To investigate annual trends, we measured the Pulse Wave Velocity (PWV) and Ankle-Brachial Pressure Index (ABI), markers for arterial stiffness, on each fifth-year medical student for 16 years. The measurements were carried out in our outpatient clinic using PWV/ABI, BP-203RPE (Omron Colin). **Results:** Backgrounds and measurements including PWV and ABI in 1515 participants showed relatively high homogeneity but there were clear differences between men and women including PWV and ABI (PWV: 1197 ± 151 vs. 1086 ± 122 cm/s, $P < 0.01$, ABI: 1.05 ± 0.08 vs. 1.00 ± 0.08, $P < 0.01$). Strong relationships were confirmed between PWV and blood pressure and between ABI and pulse rate ($P < 0.001$). Twenty-three of 897 (2.6%) men and 46 of 618 (7.5%) women showed low ABI values (< 0.9). PWV showed a mild tendency to decrease over time in both men and women. ABI showed a clear decrease over time in women (P in trend, 0.016), but no change was observed in men. Blood pressure, pulse rate, and body height maintained similar levels in either men or women in the sixteen years. **Conclusion:** These suggest a preferable decrease in the stiffness of the artery in Japanese medical students.

Keywords: Pulse wave velocity; Ankle-brachial pressure index; Annual trend; Japanese; Medical student

Introduction

Atherosclerosis of the artery begins during the very early phase of life [1]. Gradual progression of early atherosclerosis in infants, children, and young adults has been confirmed in autopsy examples in Japan [2,3]. Atherosclerosis in the coronary artery was worsening between the 70's and the 90's in young men in Japan [2]. However, the recent rise in health awareness may have had a positive influence on the condition of the arteries. To investigate this hypothesis, we measured the Pulse Wave Velocity (PWV) and Ankle- Brachial Pressure Index (ABI), markers for arterial stiffness, in the fifth academic year of medical students for 16 years.

Increased arterial stiffness is an early marker for cardiovascular disease progression and a marker for future cardiovascular accidents and mortality [4-6]. The brachial-ankle PWV (baPWV) increases annually even in young people, namely, junior high school students, in Japan [7]. ABI also increases with age in young and middle-aged individuals [8,9], but declines beyond 70 years [10]. These data suggest that annual fixed-point observation, namely, during the fifth academic year, may determine the tendency in a particular group. Although this is a serial cross-sectional study, the longitudinal decreases in PWV and ABI indicate the amelioration of arterial status in medical students.

Methods

Study Subjects and Measurements

The subjects of the study were fifth-year medical students at the University of Miyazaki. A small group of students received medical training throughout the year and underwent these measurements. This study was conducted over 16 years, from April 2003 to March 2019.

All measurements were conducted between 13:30 and 15:00 hours in our outpatient office in a quiet environment, where a constant temperature was maintained. PWV, ABI, blood pressure, and heart rate were measured using an automatic waveform analyzer (form PWV/ABI, BP-203RPE; Omron Colin, Tokyo, Japan) as reported in previous papers [11,12]. Briefly, occlusion and monitoring cuffs were placed around both sides of the brachial and ankle regions of the students in the supine position. Monitors for electrocardiogram and cardiac sounds were placed in appropriate regions on the students. All parameters were automatically calculated according to the device algorithm and printed. The described method measures baPWV, which has a high correlation with authentic carotid-femoral PWV (cfPWV) [11,13] and is useful for predicting cardiovascular mortality to the same extent as cfPWV [14]. The study protocol was approved by the ethical committees of the University of Miyazaki.

Statistical Analysis

All data were expressed as the mean ± SD. Comparisons of parameters between males and females were made by unpaired Student's t-test or one-way analysis of variance (ANOVA). Relationships between variables were analyzed by simple correlations and then evaluated using multiple regression analysis. Differences were considered statistically significant at $P<0.05$. All statistical analyses were performed using the SPSS Statistics version 22 (IBM Japan, Tokyo, Japan).

Results

The participants of the study were 1515 students, consisting of 897 men and 618 women. There were clear differences in all parameters between the males and females, as shown in Table 1; thus, sex-specific analyses were performed. The markers for arterial stiffness, namely PWV and ABI, were lower in women than in men (Table 1). A considerable number of students showed low values of ABI ≤ 0.90, which is the criterion for Peripheral Artery Disease (PAD) and increased risk for cardiovascular events [15]; in particular, the rate reached 9.7% in female students (Table 2). Also, almost one-third of the female students showed borderline ABI values (between 0.91 and 1.00) (Table 2). However, none of the students showed abnormalities that were suspected to be PAD. As reported previously [16], PWV was positively correlated with age, Blood Pressure (BP), and Pulse Rate (PR) (Table 3, Figure 1). However, ABI was negatively and closely related only to PR, but not to BP (Table 3, Figure 1), unlike in a previous report [16].

	Male	Female	Whole
n	897	618	1515
Age, years old	24.9 ± 3.1	24.2 ± 2.5**	24.6 ± 2.9
SBP, mmHg	125.0 ± 11.8	113.8 ± 10.1**	120.4 ± 12.4
DBP, mmHg	69.1 ± 8.5	65.9 ± 7.7**	67.8 ± 8.3
PR, bpm	72.0 ± 13.1	78.7 ± 13.8**	74.7 ± 13.8
PWV, cm/sec	1197 ± 151	1086 ± 122**	1152 ± 150
ABI	1.05 ± 0.08	1.00 ± 0.08**	1.03 ± 0.08
PWV: Pulse Wave Velocity; ABI: Ankle-Brachial Pressure Index; **P < 0.01, male vs. female			

Table 1: Basal characteristics of the students.

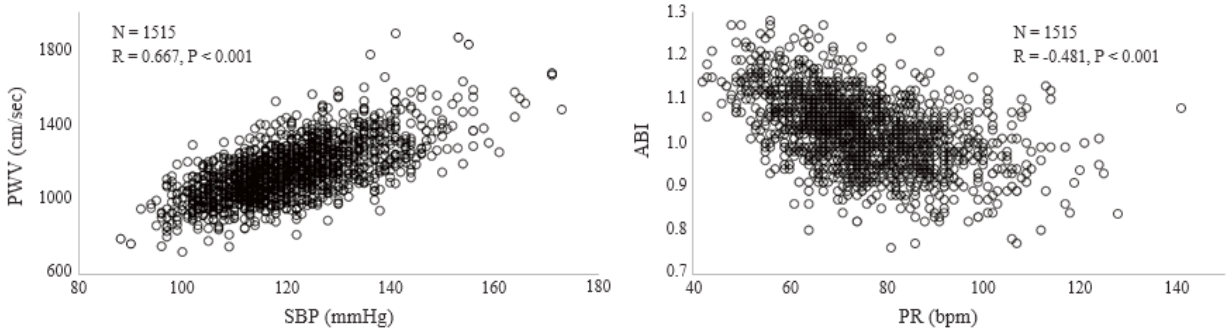


Figure 1: Relationship between Pulse Wave Velocity (PWV), Systolic Blood Pressure (SBP), Ankle- Brachial Pressure Index (ABI), and pulse rate (PR).

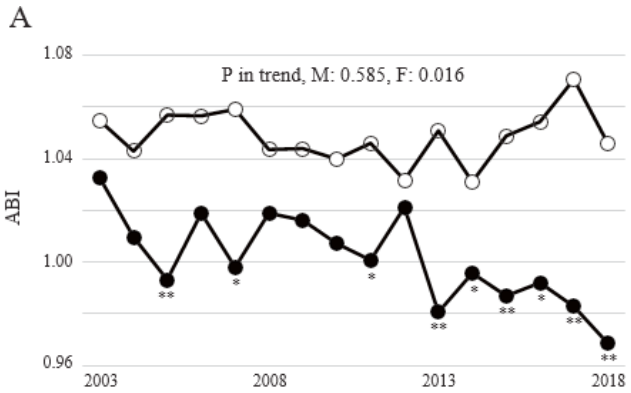
	Male	Female	Whole
n	897	618	1515
ABI ≤ 0.80	2 (0.2%)	4 (0.6%)	6 (0.4%)
0.81 ≤ ABI ≤ 0.90	28 (3.1%)	56 (9.1%)	84 (5.5%)
0.91 ≤ ABI ≤ 0.99	198 (22.1%)	224 (36.2%)	422 (27.9%)
1.00 ≤ ABI ≤ 1.10	452 (50.4%)	276 (44.7%)	728 (48.1%)
1.11 ≤ ABI ≤ 1.20	191 (21.3%)	55 (8.9%)	246 (16.2%)
1.21 ≤ ABI	26 (2.9%)	3 (0.5%)	29 (1.9%)
ABI: Ankle-Brachial Pressure Index			

Table 2: The distribution of the ABI.

	PWV		ABI	
	R	P value	R	P value
Age	0.217	<0.001	0.009	0.72
SBP	0.667	<0.001	0.015	0.56
DBP	0.627	<0.001	-0.004	0.87
PR	0.251	<0.001	-0.481	< 0.001
PWV: Pulse Wave Velocity; ABI: Ankle-Brachial Pressure Index				

Table 3: simple correlation of the parameters.

Figure 2A illustrates the sex-specific annual trend of ABI for 16 years. A clear and significant decrease in ABI was observed only in female students. The annual PWV trend showed a decreasing tendency, especially in male students, but this was not significant in the analysis using ANOVA (Figure 2B). On the other hand, multivariate analysis revealed a negative correlation between PWV and the academic year in both male and female students (Table 4). This means that the PWV has been decreasing over time. ABI and PWV were influenced by BP, PR, but there were no changes in the annual trends of BP and PR (Figure 2C).



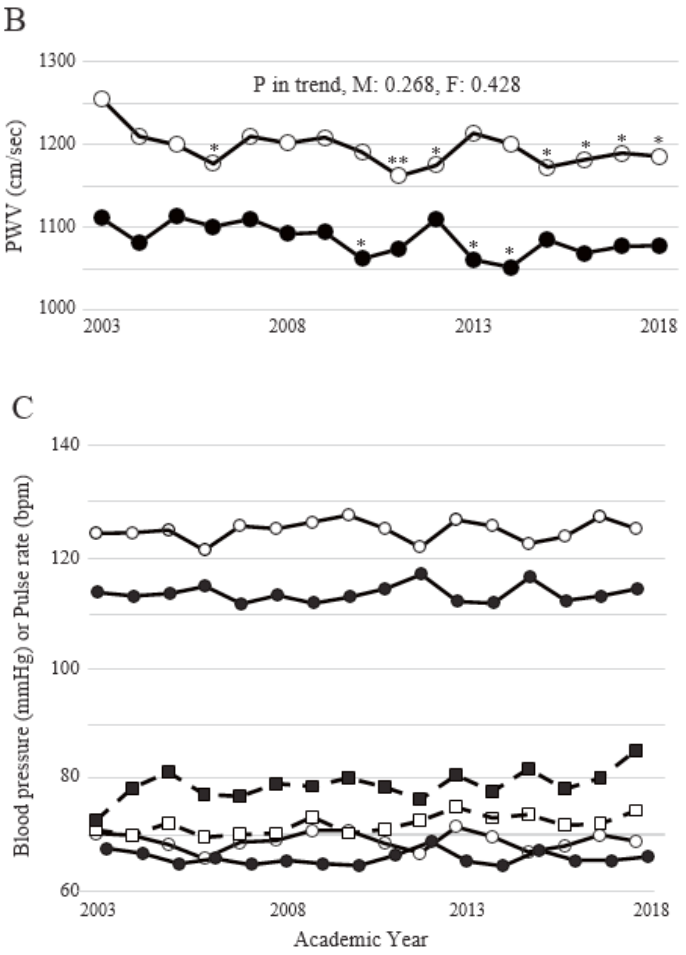


Figure 2: A: Annual trend of ankle-brachial pressure index (ABI) in medical students (○: malestudents, ●: female students). $^{*}P < 0.05$, $^{**}P < 0.01$, vs. the first year of observation(2003). B: Annual trend of pulse wave velocity (PWV) in medical students (○: male students, ●: female students). $^{*}P < 0.05$, vs. the first year of observation (2003). C: Annual trend of systolic and diastolic blood pressure (BP) (○: male students, ●: female students), pulse rate (PR) (□: male students, ■: female students).

	PWV				ABI			
	Male		Female		Male		Female	
	β	P value	β	P value	β	P value	β	P value
Age	0.131	<0.001	0.087	0.006	0.014	0.65	0.014	0.70
Systolic blood pressure	0.504	<0.001	0.572	<0.001	-0.005	0.89	0.120	0.001
Pulse rate	0.206	<0.001	0.123	<0.001	-0.409	<0.001	-0.525	<0.001
Academic year	-0.087	0.001	-0.111	<0.001	0.031	0.31	-0.098	0.005
PWV: Pulse Wave Velocity; ABI: Ankle-Brachial Pressure Index								

Table 4: Multiple correlation of the parameters.

Discussion

This is the first report on the long-term trend of indices of arterial stiffness, namely PWV and ABI, in medical students. There has been a decreasing tendency in PWV in both male and female students and a clear decrease in ABI only in female students during the last 16 years. There have been no clear changes in BP and PR that influence PWV and ABI; therefore, these changes in arterial markers may reflect favorable amelioration of arterial stiffness in young people.

Health-promoting lifestyles during university life are positively related to good health status [17]. Conversely, unhealthy lifestyles, including smoking, alcohol use, low physical activity, skipping breakfast, and poor sleep quality, are related to poor health status and may introduce the risk of lifestyle-related diseases [17-19]. Medical students, including nursing students, are reported to have characteristic physical activities and daily lifestyle habits [20-22]. Therefore, the maintenance of healthy lifestyle behaviors is very important for good university life. To achieve this, acknowledging that health is important and that students with high health literacy have healthy lifestyles is key [23]. It may be natural for medical students in Japan to have high electronic health literacy and good exercise routines [24]. In recent years, the popularization of health information and easy access to this information may have promoted healthy lifestyles among students.

ABI increased in young and middle-aged individuals with age and then decreased in the elderly [8-10]. Naturally, the baseline of ABIs in young students was expected to be low. Indeed, a significant number of students showed values of less than 1.0, and 5.9% of the students showed a value less than 0.90, which is a criterion for peripheral artery disease (Table 2). The prevalence of an ABI < 0.9 was reported to be 1.5% in men and 0.7% in women in a community-dwelling population [25]. Low ABI values in young people could be explained by low pulse wave amplification. Namely, low arterial stiffness, as indicated by a low PWV in the students, causes a low reflected wave and then decreases the pulse wave amplification in the peripheral artery, especially in the farther peripheral artery [26]. Low amplification causes low blood pressure in the farther peripheral artery, resulting in a decreased ABI. A decrease in heart rate increases pulse wave amplification [27]. This relationship was clearly shown in the students (Figure 1), where relatively homogeneous characteristics and low atherosclerosis may have contributed to a clear demonstration of the relationship. The annual increase in ABI was quite small even in a longitudinal cohort study [9]; thus, the difficulty in detecting the over-time tendency using annual fixed-point observations for different groups of students, is expected. Therefore, a clear decrease in ABI over time in female students seems to be significant (Figure 2A). On the other hand, the changes in PWV were fuzzy in trend analysis (Figure 2B). However, the negative relationship between PWV and the academic year in multiple regression analysis (Table 4) clearly suggested the over-time amelioration of PWV in male and female students.

Besides arterial factors, there may be other factors that decreased ABI only in female students. Tabara, et al. reported that the thigh muscle area showed a strong positive association with ABI [28]. The desire for thinness or an ideal body shape is widespread in young Japanese women [29,30]; therefore, decreased muscle volumes in the limbs may occur in female students.

This study has some limitations. First, we did not collect background data for the students because it was difficult due to privacy protection. Additional data may lead to other interpretations. Second, this study does not include a longitudinal follow-up of the same subjects; therefore, the secular change of each person was not clear.

In conclusion, we conducted a long-term observation of arterial stiffness markers in a relatively homogeneous population, namely fifth-year medical students. In this observation, a decreasing trend in arterial stiffness in Japanese medical students was observed.

References

1. Stary HC (2000) Lipid and macrophage accumulations in arteries of children and the development of atherosclerosis. Am J Clin Nutr 72: 1297S-1306S.

2. Imakita M, Yutani C, Strong JP, Sakurai I, Sumiyoshi A, et al. (2001) Second nation-wide study of atherosclerosis in infants, children and young adults in Japan. Atherosclerosis 155: 487-497.

3. Kisanuki A, Asada Y, Sato Y, Marutsuka K, Takeda K, et al. (2000) Coronary atherosclerosis in youths in Kyushu Island, Japan: histological findings and stenosis. J Atheroscler Thromb 6: 55-59.

4. Weber T, Auer J, O'Rourke MF, Kvas E, Lassnig E, et al. (2004) Arterial stiffness, wave reflections, and the risk of coronary artery disease. Circulation 109: 184-189.

5. Najjar SS, Scuteri A, Lakatta EG (2005) Arterial aging: is it an immutable cardiovascular risk factor? Hypertension 46: 454-462.

6. Vlachopoulos C, Aznaouridis K, Stefanadis C (2010) Prediction of cardiovascular events and all-cause mortality with arterial stiffness: a systematic review and meta-analysis. J Am Coll Cardiol 55: 1318-1327.

7. Fujiwara H, Nakajima H, Inoue F, Kosaka K, Asano H, et al. (2018) Arterial stiffness in junior high school students: longitudinal observations. Pediatr Int 60: 127-135.

8. Congnard F, Abraham P, Vincent F, Le Tourneau T, Carre F, et al. (2015) Ankle to brachial systolic pressure index at rest increases with age in asymptomatic physically active participants. BMJ Open Sport Exerc Med 1: e000081.

9. Toma Y, Ishida A, Kinjo K, Ohya Y (2016) Change in ankle-brachial index over time in a screened Japanese cohort - the Okinawa peripheral arterial disease study. Circ J 80: 2004-2009.

10. Oberdier MT, Morrell CH, Lakatta EG, Ferrucci L, AlGhatrif M (2019) Subclinical longitudinal change in ankle-brachial index with aging in a community-dwelling population is associated with central arterial stiffening. J Am Heart Assoc 8: e011650.

11. Yamashina A, Tomiyama H, Takeda K, Tsuda H, Arai T, et al. (2002) Validity, reproducibility, and clinical significance of noninvasive brachial-ankle pulse wave velocity measurement. Hypertens Res 25: 359-364.

12. Kita T, Kitamura K, Hashida S, Morishita K, Eto T (2003) Plasma adrenomedullin is closely correlated with pulse wave velocity in middle-aged and elderly patients. Hypertens Res 26: 887-893.

13. Sugawara J, Hayashi K, Yokoi T, Cortez-Cooper MY, DeVan AE, et al. (2005) Brachial-ankle pulse wave velocity: an index of central arterial stiffness? J Hum Hypertens 19: 401-406.

14. Vieceli T, Brambilla B, Pereira RQ, Dellamea BS, Stein AT, et al. (2021) Prediction of all-cause and cardiovascular mortality using central hemodynamic indices among elderly people: systematic review and meta-analysis. Sao Paulo Med J 139: 123-126.

15. Aboyans V, Criqui MH, Abraham P, Allison MA, Creager MA, et al. (2012) Measurement and interpretation of the ankle-brachial index:a scientific statement from the American Heart Association. Circulation 126: 2890-2909.

16. Ahn JH, Kong M (2011) The relationship among pulse wave velocity, ankle-brachial pressure index and heart rate variability in adult males. Korean J Fam Med 32: 406- 411.

17. Lolokote S, Hidru TH, Li X (2017) Do socio-cultural factors influence college students' self- rated health status and health-promoting lifestyles? A cross-sectional multicenter study in Dalian, China. BMC Public Health 17: 478.

18. Otsuka Y, Kaneita Y, Itani O, Jike M, Osaki Y, et al. (2020) Skipping breakfast, poor sleep quality, and Internet usage and their relation with unhappiness in Japanese adolescents. PLoS One 15: e0235252.

19. Proudfoot NA, King-Dowling S, Cairney J, Bray SR, MacDonald MJ, et al. (2019) Physical activity and trajectories of cardiovascular health indicators during early childhood. Pediatrics 144: e20182242.

20. Dąbrowska-Galas M, Plinta R, Dąbrowska J, Skrzypulec-Plinta V (2013) Physical activity in students of the Medical University of Silesia in Poland. Phys Ther 93: 384-392.

21. Mandic S, Wilson H, Clark-Grill M, O'Neill D (2017) Medical students' awareness of the links between physical activity and health. Monten J Sports Sci Med 6: 5-12.

22. Geok SK, Yusof A, Lam SK, Japar S, Leong OS, et al. (2015) Physical activity and health-promoting lifestyle of student nurses in Malaysia. J Biosci Med 3: 78-87.

23. Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K (2011) Low health literacy and health outcomes: an updated systematic review. Ann Intern Med 155: 97-107.

24. Tsukahara S, Yamaguchi S, Igarashi F, Uruma R, Ikuina N, et al. (2020) Association of eHealth literacy with lifestyle behaviors in university students: questionnaire-based cross-sectional study. J Med Internet Res 22: e18155.

25. Fujiwara T, Saitoh S, Takagi S, Ohnishi H, Ohata J, et al. (2004) Prevalence of asymptomatic arteriosclerosis obliterans and its relationship with risk factors in inhabitants of rural communities in Japan: Tanno-Sobetsu study. Atherosclerosis 177: 83-88.

26. Avolio AP, Van Bortel LM, Boutouyrie P, Cockcroft JR, McEniery CM, et al. (2009) Role of pulse pressure amplification in arterial hypertension: experts' opinion and review of the data. Hypertension 54: 375-383.

27. Safar ME, Protogerou AD, Blacher J (2009) Statins, central blood pressure, and blood pressure amplification. Circulation 119: 9-12.

28. Tabara Y, Igase M, Setoh K, Kawaguchi T, Okada Y, et al. (2018) Clinical significance of an elevated ankle-brachial index differs depending on the amount of appendicular muscle mass: the J-SHIPP and Nagahama studies. Hypertens Res 41: 354-362.

29. Takasaki Y, Fukuda T, Watanabe Y, Kurosawa T, Shigekawa K (2003) Ideal body shape in young Japanese women and assessment of excessive leanness based on allometry. J Physiol Anthropol Appl Human Sci 22: 105-110.

30. Hayashi F, Takimoto H, Yoshita K, Yoshiike N (2006) Perceived body size and desire for thinness of young Japanese women: a population-based survey. Br J Nutr 96: 1154- 1162.