Received: 23.1.2008 **Accepted: 30.6.2008**

Original Article

Driving environment in Iran increases blood pressure even in healthy taxi drivers

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Abstract

BACKGROUND: Nowadays, driving is an unseparated part of our new modern lifestyle; and we are exposed to this environment all the days for several hours whether as drivers or as riders. Many reports indicated that Iran is on the top rank of automobile-related morbidity and mortality among developed and even many developing countries that can be due to dangerous driving habits in Iran. We designed this study to find out if environment of driving have clinically important effects on blood pressure (BP) and how strong is the effect. We also examined if there were any predictors for the BP rises in driving time.

METHODS: In a cross-sectional study, 31 healthy male taxi drivers were included through a multistage proportional sampling method in winter and spring 2007. They were referred to the clinic of hypertension in Shafa Hospital, Kerman. A trained nurse measured the BPs. She also did set up the Ambulatory Blood Pressure Monitor (ABPM) on the drivers' left arms for BP recording every 30 minutes during the day. Based on the diurnal recorded BPs, the subjects were allocated into normotensive and hypertensive (systolic BP > 135 or diastolic BP > 85mmHg) groups. The difference among the clinic BPs and the driving BPs was examined by t-test in Stata version 8, followed by a multivariate analysis for exploring the main predictors for BP rises in driving time.

RESULTS: Both mean systolic and mean diastolic BPs were significantly increased from 116.85 (SE 2.28) and 74.44 (SE 2.22) mmHg in clinic to 138.64 (SE 2.77) and 95.70 (SE 2.55) mmHg during driving, respectively (P = 0.0001). Pulse pressure remained constant (P = 0.87)**.** The difference between clinic's and driving time measurements was higher in hypertensive group. Those with higher systolic blood pressures in clinic had more frequent and higher BP rises in driving time (P = 0.02).

CONCLUSIONS: Driving increased BP averagely 20 mmHg especially in those with higher BP measurements. Drivers with higher baseline systolic BPs were more prone to higher BP rises in driving time.

KEYWORDS: Driving, systolic blood pressure, diastolic blood pressure, hypertension, ambulatory blood pressure monitoring.

JRMS 2008; 13(6): 287-293

Nowadays, we experience an epidemiological transition, from communicable diseases to non-communicable ones, and the burden of diseases quickly changes to the non-communicable disorders including cardiovascular diseases.[1] The modern life style, more automobiles and less physical activity, are the most considerable reasons. Improving the life style is being recommended worldwide.[2] Driving is one of the most essential parts of new modern life style globally. Most people drive in order to do daily activities but, some others choose driving as their jobs, like taxi drivers. Similar to other jobs, drivers are exposed to environment with special characteristics. Hattori characterized the working environment of taxi drivers in Japan as follows: continuous tension caused by driv-

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ing, lack of exercise, exposure to various harmful environmental factors, changes in living and eating habits caused by irregular work schedule and pressure to fill quotas.[3] These are the potential predisposing factors for obesity, diabetes mellitus, hypertension and cardiovascular events.[4] We reviewed all the available local and international bio-medical databases and didn't find the characteristics of driving environments in Iran. However, it is obvious from the national reports that the burden of car accidents in Iran is very high and it's unique among countries all over the world.[1,5] There are about 30,000 deaths from car accidents annually in both within and between urban tracks in Iran[6] and it's mostly due to the driving culture with less attention to traffic laws[7] and the engineering of streets and roads with heavy traffics and inappropriate infrastructures of transportation system.[8] These ecological factors make driving in Iran different than others in developed countries. In addition, several epidemiological studies have shown that the prevalence of ischemic heart diseases, myocardial infarction, hypertension and subsequent mortality rates were more frequent in occupational drivers such as taxi, bus and truck drivers.[9-12] Although the mechanisms that increase the risk of cardiovascular diseases in drivers have not yet clearly defined, but long working hours with work-related stressors may play an important role on blood pressure (BP) rises during driving.[13] Kobayashi et al showed that long working hours significantly increased blood pressure in both normotensive and hypertensive taxi drivers.[13] In addition, a significant number of taxi drivers are reported to die from working excessively for long hours or are involved in serious traffic accidents caused by a sudden onset of cardiovascular disease while driving.[14] In the previous study in Kerman, we found that taxi drivers have an increased risk of hypertension compared with the control group (odds ratio: crude = 5.94, adjusted = 9.09, $P < 0.001$) and concluded that driving is an independent risk factor for hypertension.[15] However, based on the study design, we were not able to explore the exact effect of taxi driving on blood pressure. We only measured blood pressure in clinic but not during the driving. Such findings make us uncertain about the safety of coronary heart disease (CHD) patients when exposed to driving environments. Given the ethical issues, we chose only healthy taxi drivers and tested our hypothesis to see if taxi driving would have clinically important effects on BP during driving and how strong is the effect. We also examined if there were any predictors for such BP rises in driving time.

Methods

We designed a cross-sectional study and enrolled 31 male taxi drivers in winter and spring 2007, who worked for at least one year in Kerman Taxi Organization. Since taxi drivers were driving in different lines with various traffic jams, we used a multistage proportional stratum sampling method (each road as a stratum) to have a proper sample of the population. After completing the inform consent, we asked the healthy taxi drivers to come to the Blood Pressure Clinic of Shafa Hospital on a specific date at 8 am. An educated nurse interviewed the drivers and collected the demographic information and past medical history. All subjects with positive history of diabetes and coronary heart diseases were excluded. Also, she measured BP, height and weight of the individuals with standard devices and techniques. In another word, the nurse measured the drivers' blood pressures (left arm BP) with both mercurial sphygmomanometer and Ambulatory Blood Pressure Monitoring (ABPM) in a standard situation (after 5 minute rest, in a sitting position, while the left arm was positioned at the heart level). These measurements were considered as baseline BPs. All subjects were educated on the ABPM with a short person-to-person method and through a pamphlet. The ABPM device was fixed in the correct position on the left arm and was programmed to measure the BP every 30 minutes during the day and every 60 minutes during the night (figure 1).

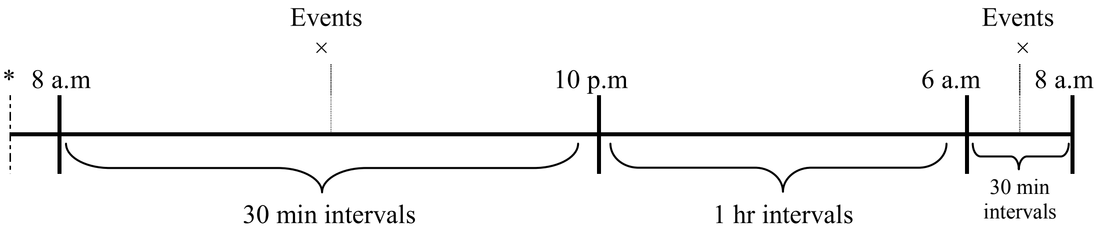


Figure 1. The procedure of BP measurements within clinic and in life environment.

The ABPM cuff was fixed on the left arm because all the drivers were driving the manual cars and had to shift the gear using right hand and such a muscular activity make noise on the BP measurements. Besides the programmed measurements (with 30/60-minute intervals), we asked the drivers to click the event button in 5-10 minutes after starting the driving, i.e., when they became relax enough, in order to have accurate BP measurements during their driving periods. Moreover, the drivers were asked to document all their activities in timetable forms during the ABP monitoring. It helped us distinguish the BP measurements in different situations such as driving, eating, sleeping, resting and exercise.

Data analysis

All the ambulatory systolic and diastolic BP measurements more than 135 and 85 mmHg, respectively, were remarked as high BPs. Also, based on average BP measurements during the day, we allocated the individuals into two groups, the hypertensive group (systolic BP > 135 or diastolic BP > 85mmHg) and the normotensive group (n = 23). We used paired t-test to assess the difference between the baseline mean systolic BP and the driving mean systolic BP and also between the baseline mean diastolic BP and the driving mean diastolic BP. The difference of BPs in the two groups (normo/hypertensive) was examined by independent t-test. The Spearman's Rho was calculated to examine the relationships between such BP measurements. Furthermore, we used multivariate analysis to model the effects of different factors including age, BMI, clinic's systolic BP, clinic's diastolic BP, clinic's mean arterial BP and number of years working as a taxi driver on the frequencies of high BPs (as dependent variable) in driving time. Data were analyzed by Stata version 8 software.

Results

Thirty-one taxi drivers were completed the study. Their average age was 42.1 (SE 2.4) years and their mean BMI was about 26.9 (SE 0.94). The average period of working as taxi drivers was about 8.6 (SE 1.4) years. Only 2 (6.45%) individuals were illiterate and most of them had a secondary school educational level. In clinic, the mean systolic and diastolic BPs were 116.85 (SE 2.28) and 74.44 (SE 2.22) mmHg, respectively. During driving, the mean systolic BP increased to 138.64 (SE 2.77) and mean diastolic BP rose up to 95.70 (SE 2.55) mmHg. Both systolic and diastolic BPs significantly increased due to driving ($P < 0.001$). We found that 8 (25.81%) taxi drivers were hypertensive; i.e., their mean BPs of daily monitoring were more than the normal range, 135/85mmHg. Individuals in normotensive group were 8.3 years older and 4.3 years more experienced in driving and had about 2.5 kg/m^2 less BMI compared with the hypertensive group, but none of the differences were statistically significant (table 1).

As it is shown in table 2, in both normotensive and hypertensive groups, clinic's measurements of systolic, diastolic and mean arterial blood pressure were significantly lower than measurements in working times (during driving). According to pulse pressure, there were no significant differences between clinic's and driving time in both groups. The difference between clinic's and driving time measurements increased in hypertensive group. However, the interaction between hypertensive group and measurement area was not statistically significant.

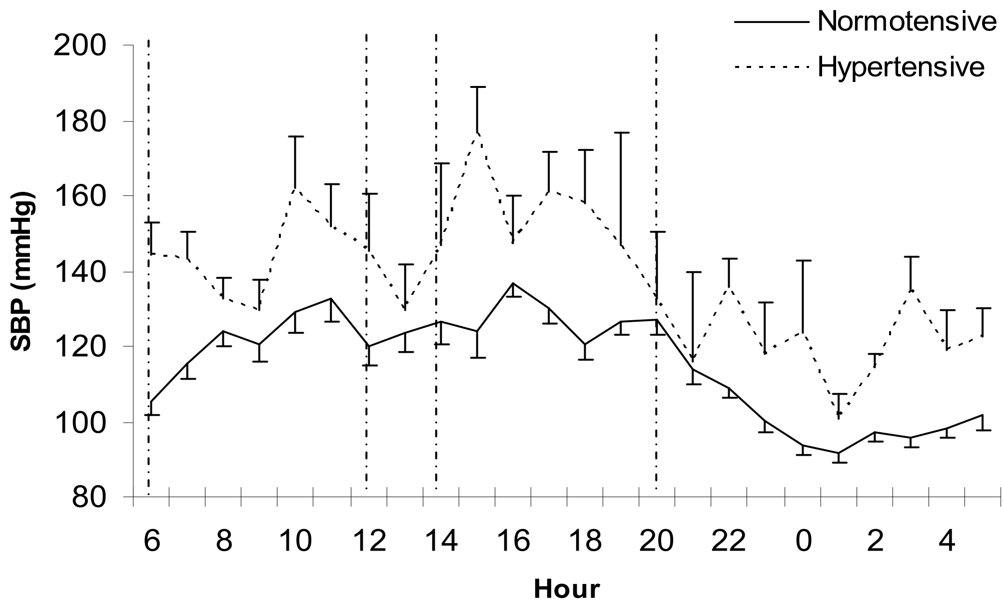
Table 1. Charactrsitcs of subjects. Each number denotes mean (SE).

Variables	Normotensive (n = 23)	Hypertensive (n = 8)
Age (years)	44.4 (2.7)	36.1 (4.9)
Experience as a driver (year)	9.7 (1.8)	5.4 (1.3)
BMI	26.2 (1.0)	28.7 (2.3)

The hypertensive group experienced more variation in systolic BP in a working day especially during the traffic jam. From early morning to 8 am, mean systolic BP decreased slowly from 144.3 mmHg to 132.7 mmHg in hypertensive group while a reverse trend occurred in normotensive group. Then, systolic BP was almost constant during the next two hours while it showed a sharp increase in hypertensive group at 10 am. Both groups had systolic BP between 120-130 mmHg during the lunch-time. Working in the afternoon, from 14 to 20 pm made a dominant difference between the two groups. The maximum systolic BP was 176.6 mmHg in hypertensive group at about 15 pm (figure 2.A). In a general view, diastolic BP changes were compatible with systolic blood pressure while it had less variation during a working day. It varied from 95 to 100 mmHg during a working day in hypertensive group. In contrast with systolic BP, diastolic BP did not decrease during the lunch-time (figure 2.B). For each subject, driving blood pressure was averagely examined 26 times in a working day. Of these measurements, systolic blood pressure was > 135 mmHg or diastolic blood pressure was > 85 mmHg in about 6.8 (SE 1.1) times. Clinic's systolic BP (β = 0.17, P = 0.05), clinic's diastolic BP (β = 0.27, P = 0.006), clinic's mean arterial BP (β = 0.26, P = 0.01), and years working as a taxi driver (β = -0.26, P = 0.05) were the only significant factors which predicted the frequency of BP rises. However, by multivariate analysis, only clinic's systolic BP remained significant in the model (β = 0.29, P = 0.02).

Table 2. BP comparision in clinic and driving time in both normo/hypertensive groups.

	Normotensive (n = 23)	Hypertensive (n = 8)	Total
Systolic BP (mmHg)			
Clinic	115.0 (1.9)	121.2 (6.1)	116.8 (2.3)
Driving time	134.7 (3.6)	149.9 (2.5)	139.2 (2.9)
P value	0.0001	0.0072	0.0001
Diastolic BP (mmHg)			
Clinic	72.1 (2.2)	80.0 (5)	74.4 (2.2)
Driving time	91.4 (2.9)	108.2 (3.3)	96.4 (2.7)
	0.0001	0.0016	0.0001
Mean Arterial BP (mmHg)			
Clinic	86.4 (1.9)	93.7 (5.3)	88.6 (2.1)
Driving time	105.9 (3.1)	122.1 (2.3)	110.7 (2.7)
P value	0.0001	0.001	0.0001
Pulse Pressure (mmHg)			
Clinic	42.9 (2.1)	41.3 (2.3)	42.4 (1.6)
Driving time	43.2 (1.1)	41.7 (4.2)	42.8 (1.4)
P value	0.94	0.84	0.87



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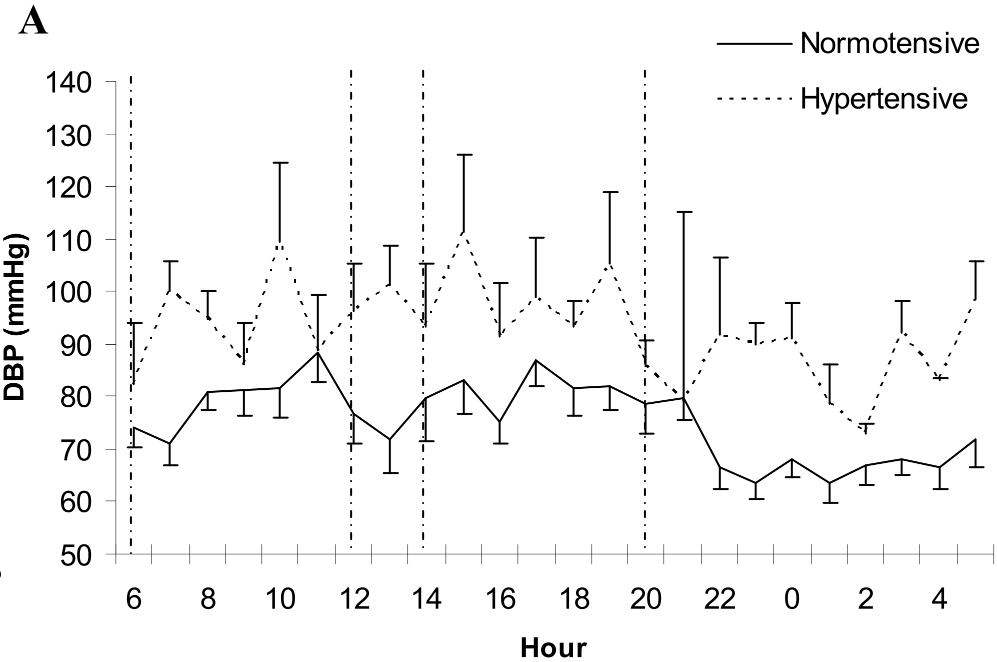

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Figure 2. Changes in systolic (A) and diastolic (B) blood pressures in both normotensive and hypertensive groups.

Discussion

Our study showed that driving increases systolic, diastolic and mean arterial BP by about 20 mmHg (compared to the measurements in clinic). As driving has the same effects on systolic and diastolic BPs, driving pulse pressure remains constant compared to clinic's measurements. People with diurnal average BP more than 135/85 mmHg, experienced more frequent and higher rises in BP during driving. Driving BPs were far away from the clinic's measurements during the rush-hour times in the morning, 10 to 12 am and after 6 pm. The best predictor for the frequency of high blood pressures during driving was the clinic's systolic BP. Compatible with other studies, our findings indicated that driving may contribute to an increased cardiovascular risk by rising and maintaining the level of BP.[13] Taxi drivers in this study have been working as a driver for long period (mean, 8.6 years), which means they had enough time to become well adapted to their works. That's why we assumed that the driving itself didn't excite them. They probably affected more adversely by work-related stressors such as dealing with passengers, looking for potential customers on the roads, waiting at taxi stations for customers and traffic jams.[16-19] Based on our findings, such stressors have more effects on the hypertensive groups. This finding is compatible with other studies that reported cardiac vagal tone and modulation decrease and cardiac sympathetic tone increases in hypertensive individuals.[20-22] Melamed et al showed that long-term occupational noise exposures caused chronic blood pressure increases in workers who performed complex jobs.[23] It also increased systolic BP more than diastolic BP. But, systolic BP and diastolic BP increase equally in the short-term noise exposures.[24] As it's obvious, one of the most frequent stressors during driving is exposure to very noisy environments. The effects of noisy environments on blood pressure in our study samples were equal in both systolic and diastolic BPs. It can be concluded that the most effects of driving on BP comes from a short-term pattern effects similar to the Melamed et al findings.[23] Although we had no access to the original data on traffic loads in Kerman, as a general view, we found more discrepancy between driving BPs and clinic's measurements during rush hours in Kerman that indicates the necessity for more cautions about CHD patients who drive in such stressful situations. Another important issue was the frequency of blood pressure rise (more than 135/85 mmHg) during driving time. Our study showed that individuals with higher systolic BP are more prone for having such BP crisis during driving. Such a finding indicates that physicians should consider driving effects on BP in patients with high BP especially systolic one. The current study showed the effects of driving on healthy taxi drivers, but further investigations on individuals with and without cardiovascular disorders are highly recommended. However, we should acknowledge the limitations of the study. There was no control group. As mentioned above, having more groups such as healthy non-taxi drivers, hypertensive and patients with positive history of myocardial infarction would illuminate a better view on the effects of driving in different individuals and better evidence based decision making for such patients. Also, we divided subjects into two groups, normotensive and hypertensive, based on the average diurnal systolic BP > 135 mmHg or diastolic BP > 85 mmHg. Probably it would be better if we considered hypertensive patients as the control group. Finally, we concluded that driving in Kerman increases blood pressure by 20 mmHg. It affects both normotensive and hypertensive groups, while the effects of driving on BP are much more significant in hypertensive group. Driving has the same effects on systolic and diastolic BPs; and during the rush hours; the driving effects on BP increase. Those with higher systolic BP in clinics are more prone to high BP during driving.

Acknowledgments

This study was supported by a grant from Kerman Medical University, Vice Chancellor for Research Affairs (Physiology Research Center). We would like to appreciate all those people contributed in this project especially Mrs. Veissi (the nurse working in Hypertension Clinic) and Mr. Moeenaddini (vice chancellor of Kerman Taxi Driver Organization) and Mr. Saeed Sadeqi for all of his kind aids in data collection.

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