

ORIGINAL ARTICLE

# The Metabolic Syndrome and its Association with Over Time Driving in Iranian Professional Bus Drivers

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## ABSTRACT

The aim of the study was to determine the prevalence of metabolic syndrome (MeS) in professional bus drivers, and its association with overtime working hours among those drivers in Urmia, Iran. In this cross sectional study the studies population was 626 professional bus drivers, aged 20-69 yr. The MeS (according to the National Cholesterol Education Program Adult Treatment Panel III), Waist circumference, Systolic blood pressure, Diastolic blood pressure, Fasting plasma glucose, Triglyceride, HDL-cholesterol, age, and working time per week. The overall prevalence of the metabolic syndrome was 32.4%. The prevalence of the MeS was higher than the general Iranian population. There was a statistically significant positive relationship between over time driving and MeS (P: 0.028). This represents an odds ratio of 1.46 (95%CI: 1.04 – 2.05). The metabolic syndrome is becoming a noteworthy health problem in bus drivers; therefore, early detection and appropriate intervention need to be established.

**Keywords:** Metabolic syndrome, Overtime work, Bus driving, NCEP- ATP III

## INTRODUCTION

The metabolic syndrome (MeS) is a complex association of several interrelated abnormalities that increase the risk of cardiovascular events and progression to diabetes mellitus [1-6]. Age-adjusted MeS prevalence among adults aged 20–70 years in the USA has been reported to be 24% in men [7]. Reaven et al. described the MeS or insulin resistance syndrome in 1988 [8]. In 1998, World Health Organization (WHO) [9] provided a definition of the MeS. Although there are several definitions, the most commonly used are the NCEP criteria to clinically identify patients. The National Cholesterol Education Program- Adult Treatment Panel III (NCEP- ATP III) released a definition in 2001, and proposed that the MeS can be recognized clinically by a clustering of simple clinical measures [10-12]. The drivers' working environment is characterized by numerous stress factors such as lack of physical activity due to overtime working in a fixed

position, disruption in diet, and sleep habits caused by irregular work schedule [13, 14]. Ever since the 1950s, researchers have been looking at the causes of heart diseases in bus drivers. Fifty-four years ago, Morris et al., reported lower rates of coronary heart disease in bus conductors than in less occupationally active bus drivers. This seminal U.K investigation was undertaken using data from two cohorts of British workers [15]. Long distance professional drivers have particular life styles. They are likely to take fast foods frequently and fail to exercise regularly.

The objectives of this study were to estimate the prevalence of the MeS using the NCEP- ATP III definition among professional long distance drivers as a subgroup of general population, and to determine the role of overtime working on MeS.

## MATERIALS AND METHODS

### Study subjects

The study was cross sectional. During the regular medical check up of long distance and professional bus drivers to assess their occupational health status, drivers residing in Urmia referred from December 2006 to

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**Table 1.** Frequency, Odds Ratio of metabolic syndrome amongst age groups

Age Groups	Number of subjects	Frequency of Metabolic syndrome	Prevalence (%)	Odds Ratio (Relative to 20-29 age group) *	P-Value *
20-29	137	19 (13.86%)	13.9	1.00	--
30-39	195	48 (24.61%)	24.6	2.03	0.017
40-49	186	77 (41.39%)	41.4	4.39	<0.001
50-59	91	49 (53.85%)	53.8	7.25	<0.001
60-69	17	10 (58.82%)	58.8	8.87	<0.001
Total	626	203 (32.43%)	32.4		

\* P- Value for Score test for trend of odds: <0.001

March 2007 to our occupational health clinic were included in the study. Subjects were referred to Urmia Occupational Medicine Center by the Public Health Office of Urmia City for annual medical check up. These check ups are mandatory for all the professional long distance drivers to renew their driving license. The sampling method was convenient. The drivers who were on the job for less than one calendar period and those who rejected to participate in the study were excluded.

According to the (NCEP- ATP III) definition, a person must have at least 3 of the following conditions to have the MeS: elevated fasting plasma glucose:  $\geq 110$  mg/dl (6.1 mmol/l), elevated triglycerides:  $\geq 150$  mg/dl (1.7 mmol/l), low HDL: <40 mg/dl (1.03 mmol/l) in men and <50 mg/dl (1.3 mmol/l) in women, high blood pressure: systolic blood pressure  $\geq 130$  mmHg or diastolic blood pressure  $\geq 85$  mmHg, or large waist circumference:  $\geq 102$  cm in men and  $\geq 88$  cm in women. It has also been shown that the prevalence of the MeS become more frequent as obesity increases [11, 12].

### Study contents

#### Medical history and clinical examination

According to a standard protocol, trained physicians examined all the participants. Their demographic data, medical history, smoking habits and driving time in a week were obtained using a standardized questionnaire. Waist circumference was measured at the level of the umbilicus in the standing position of subjects.

The subjects' blood pressure was measured after a five -minute rest, using a standard mercury sphygmomanometer with a suitable cuff calibrated by Iranian Institute of Standards and Industrial Researches. Two consecutive diastolic and systolic blood pressures were recorded on the right arm. If the two-measurement difference exceeded 5%, blood pressure was measured for a third time. There were at least 30 seconds intervals between the measurements; the average of the two closest readings was considered as the subject's blood pressure.

#### Definition of MeS

All subjects were screened for MeS. The criteria used for the diagnosis of the MeS were the NCEP- ATP III criteria that included the presence of three or more of the following components: abdominal obesity, high blood pressure, high fasting plasma glucose, hypertriglyceridemia, and low HDL-cholesterolemia.

#### Serum lipid and glucose analysis

Baseline blood samples were drawn into vacutainer tubes between 7:00 to 9:00 a.m. All the participants were fasted  $\geq 10$  h. Fasting plasma glucose and lipids were quantified at the time of specimen collection in the central laboratory of Urmia University of Medical Sciences, a reference laboratory that has served Urmia residents for decades. Blood glucose and lipids, including triglycerides, and high-density lipoproteins were analyzed using a BT-3000 auto-analyzer (Biotechnica, Rome, Italy). The HDL cholesterol and triglyceride were assayed using enzymatic tests with commercially available kits (Pars Azmoon Inc., Iran). All samples were analyzed when daily internal quality control which matched the acceptable criteria.

#### Definition of overtime driving

Driving more than 45 hours per week was considered as overtime driving work.

#### Data analysis

The data are presented as frequencies, percentages, and Odds ratios (OR). We used STATA 8 (Stata Corporation, Texas) for data analysis. Chi square test was used to evaluate differences among categorical data. Score test for trend was used to detect a trend among categories of ordered categories.

To evaluate the differences among continuous variables, student *t*-test and analysis of variance were used accordingly. Type I error level was set to 5% i.e. P-Value less than 0.05 was considered statistically significant. To adjust type I error for multiple testing, a Dunnett *t*-test was used while the mean of several groups was compared with the mean of the reference group.

### RESULTS

A total of 626 male drivers with the mean age of  $38.8 \pm 10.07$  were included in the study. Two hundred and three subjects (32.4%; 95%CI: 28.8% - 36.2%) were found to be MeS cases.

The drivers with MeS were older than others and their mean age was  $43.4 (\pm 9.66)$  versus  $36.64 (\pm 9.53)$  years for non-MeS subjects.

Two hundred and fifty two drivers were smokers (40.3%; 95% CI: 36.4% - 44.2%). The mean age of the smokers and non-smokers was  $39.7 \pm 9.94$  and  $38.2 \pm 10.13$  respectively, the difference was not statistically significant.

**Table 2.** Number of criteria identifying MeS in drivers of different age groups

Age groups	Mean number of components of MeS	Mean Difference with first age group	Dunnett t-tests P-Value*
20-29	1.42	0	--
30-39	1.77	.3532	0.038
40-49	2.24	.8259	0.000
50-59	2.63	1.2103	0.000
60-69	2.71	1.2898	0.000
Total	1.98		

\*  $\alpha$  level was adjusted for multiple comparison**Table 3.** Over time driving and its association with metabolic syndrome

Overtime working	Metabolic syndrome		Total	P value	OR(95%CI)
	Yes	No			
Yes	95 37.4%	159 62.6%	254 100.0%	.028	1.461 (1.041-2.049)
No	108 29.0%	264 71.0%	372 100.0%		
Total	203 32.4%	423 67.6%	626 100.0%		

**Table 4.** Waist circumference, blood pressure, and biochemical blood indices in over time driving versus normal driving hours groups

Indices	Overtime working	N	Mean	Std. Deviation	P-Value
Waist circumference	No	372	93.4	11.96	032
	Yes	254	95.5	11.31	
Systolic blood pressure	No	372	124.5	16.33	NS*
	Yes	254	126.8	19.59	
Diastolic blood pressure	No	372	78.8	10.86	039
	Yes	254	80.7	11.75	
FBS	No	372	98.4	21.46	NS*
	Yes	254	100.3	25.21	
TG	No	372	174.9	91.83	NS**
	Yes	254	189.4	102.54	
HDL	No	372	38.1	7.15	NS*
	Yes	254	37.7	7.74	

\* Not Significant

\*\* Not Significant when  $\alpha$  is set to .05 but significant if  $\alpha$  considered .10

The prevalence of MeS in smokers (31.0%) was similar to non-smokers (33.4%); the difference was not statistically significant.

By increasing the age group, the prevalence of MeS among the drivers increased continuously (Table 1). There was a linear association between the age group and the prevalence of MeS (Test for trend  $p < 0.001$ ).

The number of criteria defining MeS increased by increasing age groups (Table 2); the association was statistically significant (P Value for ANOVA  $< 0.001$ ).

Two hundred and forty five drivers (40.6%) reported overtime driving work schedule. There was a statistically significant direct association between over time driving and MeS (OR: 1.46; 95%CI: 1.04 – 2.05) as shown at Table 3.

The waist circumference and diastolic blood pressure was higher in overtime working drivers (Table 4). The mean systolic blood pressure, FBS and TG in this group was higher than the normal working time group but the difference was not statistically significant (Table 4). The mean age of overtime drivers was 39.8

$\pm 9.60$  compared to  $38.2 \pm 10.35$  to other drivers ( $p < 0.05$ ).

## DISCUSSION

The results of the present study demonstrate that in professional long distance drivers, MeS is significantly associated with over time working. The study suggests that MeS is becoming a noteworthy health problem among the Iranian bus drivers. Therefore, early detection and healthy lifestyle education programs need to be established.

Although the sampling method was convenient, the subjects were considered a random sample of all the long distance drivers as it is mandatory for them to refer to occupational health clinics for renewal of their driving licence; and the study was arranged on a convenient sample of those referred to such a clinic. Azizi et al. in the first investigation of the MeS in Iran documented a high prevalence of this disorder among Tehran's population. According to them, 24% of the studied men had MeS on the basis of NCEP-ATP III criteria as the following: the lowest prevalence was seen in the 20–29 age group (9.8%), followed by 30–39 (16.3%), 40–49 (25.5%), 50–59 (33.9%),  $\geq 70$  (34.5%),

and 60–69 (37.9%) age groups [16]. However, we found a higher prevalence of MeS in drivers compared to the same age-sex group in the study of Azizi et al. [32.4% versus 24%] [16]. The prevalence of the MeS increases with age [17]. Stress at work is an important risk factor for the MeS [18]. The increase in the prevalence of MeS has been accompanied by a parallel increase in the prevalence of obesity. Obesity, specifically visceral obesity, is of key importance in the development of cardiovascular morbidities and mortalities associated with the MeS. Visceral adipocytes are insulin-resistant, highly metabolically active, and an important source of cytokines which serve as stimulator of several pathophysiological processes such as dyslipidemia, hypertension, renal damage, and reduced thrombolysis [19–21]. An investigation among bus drivers in Taipei showed that the rates of obesity, hypertension, hypercholesterolemia, hypertriglycerolemia and ischemic heart disease were significantly higher than comparable groups of skilled workers [22]. A controlled cohort study that compared CHD risk factors among bus drivers and industrial workers in Norway showed that the bus drivers had higher mean values of serum cholesterol, serum triglycerides, systolic, and diastolic blood pressure [23]. Paradis et al. have done a historical cohort study, which compared Montreal bus drivers to the general population of the greater Montreal. According to them, there was only a small and non-significant excess of ischemic heart disease mortality among the bus drivers as a whole; however, a significant increase was found in a subgroup of drivers with less than 30 years of employment [24]. These findings were consistent with a Swedish study which compared Gothenburg bus drivers with other occupations during the same period. The study indicated that the increase in risk of CHD among middle-aged bus drivers occurred independently of standard risk factors [25]. Some investigators have reported that metabolic changes have been observed to occur independently of poor diet, and physical inactivity. Branth et al. concluded that despite regular exercise and a proper diet, subjects under prolonged stress developed metabolic alterations including distinctive central obesity, biochemical changes and a slight hypertension towards the MeS [26]. Dekker et al. suggested that although the MeS increases the risk for cardiovascular events, in clinical practice, a more informative assessment can be obtained by taking into account the number of individual risk factors [27]. The normal working hours does not exceed 40 hours per week, in practice it seems that many drivers work longer than recommended hours of working week. On the other hand, many drivers work complicated shift systems due to irregular overtime working hours, which lead to not enough opportunities for recovery and unwinding. [14]. In a retrospective longitudinal study in Italy, Biggi et al. studied the relationship between permanent night work and metabolic and cardiovascular risk factors. They concluded that night and shift work is associated with significant metabolic disturbances and may be risk factors for metabolic and cardiovascular disorders due to interference with diet, circadian metabolic rhythms, and lifestyle [28]. These studies considered the variables involved in MeS individually. We believe

although poor diet, and physical inactivity are common in professional drivers, it seems the exact reasons for higher prevalence of MeS in comparison with general population may be due to occupational factors among drivers. Our subjects were self-employed; and their overtime working may result in more income but there is little if any difference in their diet. Food is not that expensive in Iran so all such drivers could afford any food they wish. Moreover, they have similar limited options to have their meals. Since the only option they have is to have their meals in inter-city restaurants. Therefore, it seems that the effect of poor diet and physical inactivity on MeS and its related disorders had been considered less than long-term driving stress. We believe that with the ageing of driving occupants, the prevalence of MeS, and its related disorders will probably increase to levels more than those described in general population, notably in middle-aged drivers' population.

In summary, the high prevalence of MeS among professional drivers might be due to poor diet and physical inactivity. We believe our data can support conclusions drawn in other studies cited above that indicate that the working environment has a significant role in the occurrence of MeS. The notion of long-term driving stress should not distract our attention from working the environment of drivers such as night and shift working and also poor diet, and physical inactivity. Hence, more research is needed to identify potential moderators of long-term stressors on MeS in professional drivers. Identifying the MeS in the occupational setting has several advantages. It discovers workforces who are at increased risk for both cardiovascular diseases and diabetes mellitus. Diagnosis should more be focused on clinical attention to the underlying causes notably occupational stressors and other lifestyle factors. Our study had potential limitations. Firstly, our study was a cross-sectional and not a longitudinal training study. Secondly, the cross-sectional design could result in either selection bias, which could lead to over or underestimation of true association. This finding requires replication in other designs and settings to establish its validity. Further data will be collected on the samples of professional drivers in a longitudinal basis for this study to evaluate the long-term effect of driving stress on MeS.

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# REFERENCES

1. Isomaa B, Almgren P, Tuomi T, Forsen B, Lahti K, Nissen M, Taskinen MR, Groop L. Cardiovascular morbidity and mortality associated with the Metabolic syndrome. *Diabetes Care* 2001; 24(4):683-9.
2. Bonora E, Kiechl S, Willeit J, Oberhollenzer F, Egger G, Bonadonna R, Muggeo M. Carotid atherosclerosis and coronary heart disease in the Metabolic syndrome. *Diabetes Care* 2003; 26(4):1251-7.
3. Ford ES. The Metabolic syndrome and mortality from cardiovascular disease and all-causes: findings from the National Health and Nutrition Examination Survey II Mortality Study. *Atherosclerosis* 2004; 173 (2):309-14.
4. Girman CJ, Rhodes T, Mercuri M, Pyorala K, Kjekhus J, Pedersen TR, Beere PA, Gotto AM, Clearfield M. The Metabolic syndrome and risk of major coronary events in the Scandinavian Simvastatin Survival Study and the Air Force/Texas Coronary Atherosclerosis Prevention Study. *Am J Cardiol* 2004 ;93(2):136-41.
5. Malik S, Wong ND, Franklin SS, Kamath TV, L'Italien GJ, Pio JR, Williams R. Impact of the Metabolic syndrome on mortality from coronary heart disease, cardiovascular disease, and all causes in the United States adults. *Circulation* 2004; 110(10):1245-50.
6. Lorenzo C, Okoloise M, Williams K, Stern MP, Haffner SM. The Metabolic syndrome as predictor of type 2 diabetes. *Diabetes Care* 2003; 26(11):3153-9.
7. Ford ES, Giles WH, Dietz WH. Prevalence of the Metabolic syndrome among US adults. Findings from the Third National Health and Nutrition Examination Survey. *JAMA* 2002; 287(3):356-9.
8. Reaven GM. Role of insulin resistance in human disease. *Diabetes* 1988; 37(12):1595-607.
9. Alberti KG, Zimmet PZ. Definition, diagnosis and classification of diabetes mellitus and its complications. Part 1: diagnosis and classification of diabetes mellitus provisional report of a WHO consultation. *Diabet Med* 1998; 15 (7):539-53.
10. NIH. Third Report of The National Cholesterol Education Program Expert Panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III), National Institutes of Health, Bethesda, NIH Publication. May 2001.
11. Mokdad AH, Serdula MK, Dietz WH, Bowman BA, Marks JS, Koplan JP. The spread of the obesity epidemic in the United States, 1991-1998. *JAMA* 1999; 282(16):1519-22.
12. Mokdad AH, Bowman BA, Ford ES, Vinicor F, Marks JS, Koplan JP. The continuing epidemics of obesity in the United States. *JAMA* 2001; 286(10):1195-200.
13. Kurosaka K, Daida H, Muto T, Watanabe Y, Kawai S, Yamaguchi H. Characteristics of Coronary Heart Disease in Japanese Taxi Drivers as Determined by Coronary Angiographic Analyses. *Industrial Health* 2000; 38(1):15-23.
14. Kompier MA J. Bus drivers: Occupational stress and stress prevention. ILO., Geneva, 1996.
15. Morris JN, Heady JA, Raffle PAB, Roberts CG, Parks JW (1953) Coronary heart disease and physical activity of work. *Lancet* 1953; 265(6796):1111-20.
16. Azizi F, Salehi P, Etemadi A, Zahedi-Asl S. Prevalence of Metabolic syndrome in an urban population: Tehran Lipid and Glucose Study. *Diabetes Res Clin Pract* 2003; 61(1):29-37.
17. Ko GT, Cockram CS, Chow CC, Yeung V, Chan WB, So WY, Chan NN, Chan JC. High prevalence of Metabolic syndrome in Hong Kong Chinese-comparison of three diagnostic criteria. *Diab Res Clin Pract* 2005; 69(2):160-8.
18. Chandola T, Brunner E, Marmot M. Chronic stress at work and the Metabolic syndrome: prospective study. *BMJ* 2006; 332(7540):521-5.
19. McFarlane SI, Banerji M, Sowers JR. Insulin resistance and cardiovascular disease. *J Clin Endocrinol Metab* 2001; 86(2):713-8.
20. DeFronzo RA, Ferrannini E. Insulin resistance: a multifaceted syndrome responsible for NIDDM, obesity, hypertension, dyslipidemia, and atherosclerotic cardiovascular disease. *Diabetes Care* 1991; 14(3):173-94.
21. Bjorntorp P. "Portal" adipose tissue as a generator of risk factors for cardiovascular disease and diabetes. *Arteriosclerosis* 1990; 10(4):493-6.
22. Wang PD, Lin RS. Coronary heart disease risk factors in urban bus drivers. *Public Health* 2001; 115(4):261-4.
23. Hartvig P, Midttun O. Coronary heart disease risk factors in bus and truck drivers. A controlled cohort study. *Int Arch Occup Environ Health* 1983; 52(4):353-60.
24. Paradis G, Theriault G, Tremblay C. Mortality in a historical cohort of bus drivers. *Int J Epidemiol* 1989; 18 (2):397-402.
25. Rosengren A, Anderson K, Wilhelmsen L. Risk of coronary heart disease in middle-aged male bus and tram drivers compared to men in other occupations: a prospective study. *Int J Epidemiol* 1991; 20(1):82-7.
26. Branth S, Ronquist G, Stridsberg M, Hambræus L, Kindgren E, Olsson R, Carlander D, Arnetz B. Development of abdominal fat and incipient Metabolic syndrome in young healthy men exposed to long-term stress. *Nutr Metab Cardiovasc Dis* 2007; 17(6):427-35.
27. Dekker JM, Girman C, Rhodes T, Nijpels G, Stehouwer CDA, Bouter LM, Heine RJ. Metabolic syndrome and 10-Year Cardiovascular Disease Risk in the Hoorn Study. *Circulation* 2005; 112(5):666-73.
28. Biggi N, Consonni D, Galluzzo V, Sogliani M, Costa G. Metabolic syndrome in permanent nightworkers. *Chronobiol Int* 2008; 25(2):443-54.