Letter to the Editor

Prevalence of Metabolic Syndrome in Chinese Nickel-exposed Workers

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The prevalence of metabolic syndrome (MS) was investigated in Chinese nickel-exposed workers. A total of 35 104 subjects were enrolled in this study. The age-adjusted prevalence of MS, BMI≥25, diabetes, hypertension, and abnormal lipid was 13.9%, 29.5%, 12.8%, 27.5%, and 47.1%, respectively. The prevalence of BMI≥25, hyperglycemia, and hypertension increased with the age of males and females, and was higher in males than in females (37.1% *vs* 21.5%, 15.9% *vs* 12.1%, 35.0% *vs* 24.3%, 54.3% *vs* 40.4%).

Metabolic syndrome (MS) increases the risk to diabetes, cardiovascular disease (CVD), and kidney disease, as well as cardiovascular mortality[1-2]. MS is characterized by overweight, hypertension, blood glucose, and dyslipidaemia. The prevalence of MS increases in the West. The age-adjusted prevalence of MS is 9.8% in males and 17.8% in females in China[3]. However, limited information is available on the prevalence of MS in Chinese nickel-exposed workers. The present study aims to investigate epidemiology of MS in Chinese nickel-exposed workers.

Jinchuan Group Co., Ltd. (JNMC) is the largest nickel producer in China. The output of nickel accounts for over 90% of the total production in this country. There are more than 5 000 workers in JNMC. Since 2011, the workers have been eligible for medical examination every two years. Of the 35 890 subjects who underwent the medical examination, 35 104 (21 353 females with a mean age of 47.7 years and 13 751 males with a mean age of 48.2 years) were enrolled in the present study.

Data were collected with questionnaire. Physical examination was performed by clinicians at the Workers' Hospital of JNMC as previously described[4]. Their weight was measured to 0.1 kg, their height was measured to 0.1 cm, their body-mass index (BMI) was calculated as weight in kilogram divided by the square of height in meters, and their arterial blood pressure was measured 3 times at sitting position after 5 min of rest.

The participants underwent biochemical tests in the morning after an overnight fasting. Fasting blood sample (6 mL) was taken from each participant and stored for laboratory tests of fasting blood glucose (FPG), TC, HDL-C, LDL-C, TG, and creatinine.

MS was assessed according to the Chinese Diabetes Society definition as previously described[5]. Participants were diagnosed with MS when they had 3 or more of the following indications: (1) BMI≥25.0 kg/m^2, (2) TG≥1.70 mmol/L or HDL-C <0.9 mmol/L in males and <1.0 mmol/L in females, (3) systolic blood pressure ≥140 mm Hg or diastolic blood pressure ≥90 mm Hg, (4) FPG ≥6.1 mmol/L or 2-h plasma glucose(2HPG) ≥7.8 mmol/L. Participants met the criteria for high blood pressure or high fasting glucose concentration if they currently used hypotensorsor oral hypoglycemic agents.

The prevalence of MS was adjusted according to the Sixth National Population Census in 2010. Association between categorical variables was tested following the contingency tables and X^2 test. The relation between age and MS was analyzed by Spearman correlation analysis. P<0.05 was considered statistically significant.

The age-adjusted prevalence of MS, BMI≥25, diabetes, hypertension, and abnormal lipid was 13.9%, 29.5%, 12.8%, 27.5%, and 47.1%, respectively (Table 1). The prevalence of MS was higher in males than in females (16.4% *vs* 10.4%).

The gender- and age-adjusted prevalence of BMI≥25 and abnormal lipid is listed in Table 2. The

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prevalence of BMI≥25, hyperglycemia, hypertension, and abnormal lipid was higher in males than in females (37.1% *vs* 21.5%, 15.9% *vs* 12.1%, 35.0% *vs* 24.3%, 54.3% *vs* 40.4%). Spearman correlation analysis showed that age was positively related with MS. Except for abnormal lipid in males, the prevalence of overweight, hyperglycemia, and hypertension increased with age both in males and in females ($P<0.05$).

Debates mellitus is diagnosed according to the definition of MS[6]. Different definitions of MS may lead to different prevalence of MS[7]. The CDS definition is more sensitive in predicting the risk of cardiovascular disease (CVD) than the other definitions[8-9]. In addition, the CDS definition is more simple, practical and easier to popularize. The Chinese Diabetes Society definition was thus used in the present study.

No data are available so far on the prevalence of MS in nickel-exposed workers of China. Li Z-Y et al. investigated the prevalence of MS in 16 342 subjects aged 20-90 years in Beijing, China, showing that the age-adjusted prevalence of MS was 13.2% (15.7% in males and 10.2% in females) according to the CDS definition of MS[8]. It was reported that the age-adjusted prevalence of MS was 9.8% in males and 17.8% in females in China[3]. In the present study, the overall age-adjusted prevalence of MS in Except for Chinese nickel-exposed workers was 13.9%. The differences may be mainly due to the different sources of populations and the different sampling procedures.

In the present study, the prevalence of MS was higher in males than in females exposed to nickel, which is consistent with that reported in a previous study[8]. However, a study showed that the prevalence of MS was higher in females than in males[3]. The difference may be due to the higher prevalence of abnormal lipid and BMI≥25 in males than in females exposed to nickel. The prevalence of

Table 1. Age-adjusted Prevalence of MS, BMI≥25, Diabetes, Hypertension, and Abnormal Lipid in Males and Females

Items	Male (21 353)		Female (13 751)		Overall (*N*=35 104)	
	n	Age-adjusted Prevalence	*n*	Age-adjusted Prevalence	*N*	Age-adjusted Prevalence
MS	3 946	16.4	1 516	10.4	5 462	13.9
BMI≥25	7 925	35.7	2 958	20.3	10 883	29.5
Diabetes	3 396	13.7	1 669	11.7	5 065	12.8
Hypertension	7 471	30.8	3 341	22.8	10 812	27.5
Abnormal Lipid	11 586	52.8	5 549	38.5	17 135	47.1

Table 2. Prevalence of BMI>25 and Abnormal Lipid in Males and Females

Age	Participants			BMI≥25			High FBG or Medication Use			Hypertension or Medication Use			Abnormal Lipid		
	Male	Female	Overall	Male	Female	Overall	Male	Female	Overall	Male	Female	Overall	Male	Female	Overall
20-25	577	304	881	23.2	6.6	17.5	4.0	4.3	4.1	10.9	2.3	7.9	38.3	25.0	33.7
25-30	1 440	629	2 069	30.6	11.3	24.7	4.6	4.3	4.5	14.2	4.8	11.3	46.6	28.6	41.1
30-35	1 080	536	1 616	31.9	9.1	24.3	4.8	5.8	5.1	15.6	2.6	11.3	52.4	23.3	42.8
35-40	2 679	1 869	4 548	33.9	8.8	23.6	6.7	5.7	6.3	20.9	7.1	15.2	53.6	29.1	43.5
40-45	4 324	3 377	7 701	36.2	12.7	25.9	9.3	7.7	8.6	25.7	11.6	19.5	56.8	36.0	47.7
45-50	3 268	2 414	5 682	40.0	17.6	30.5	14.9	9.7	12.7	34.5	18.7	27.8	58.6	38.3	50.0
50-55	1 303	991	2 294	40.9	25.9	34.4	21.1	13.7	17.9	40.8	30.2	36.2	61.3	49.5	56.2
55-60	1 391	1 073	2 464	42.0	35.3	39.1	24.4	17.6	21.5	47.1	41.5	44.6	57.1	54.0	55.7
60-65	1 879	1 247	3 126	41.8	44.3	42.8	27.9	22.5	25.8	51.3	54.0	52.3	54.9	57.4	55.9
65-70	1 312	814	2 126	42.5	48.6	44.8	31.2	28.7	30.2	57.7	66.5	61.1	53.3	52.5	53.0
≥70	2 100	497	2 597	36.5	43.3	37.8	30.3	32.2	30.7	63.2	71.6	64.8	47.5	54.5	48.9
Overall	21 353	13 751	35 104	37.1	21.5	31.0	15.9	12.1	14.4	35.0	24.3	30.8	54.3	40.4	48.8
r_s	-	-	-	0.855	0.936	0.909	0.991	0.989	0.999	0.999	0.991	0.998	0.364	0.927	0.782
P	-	-	-	0.008	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.272	<0.001	0.005

Note. r_s: Spearman's correlation coefficient, *P*: *P* value.

BMI≥25, hyperglycemia, and hypertension increased with age in both genders. MS can lead to hypertension, abnormal lipid, and overweight in female workers aged over 60 years, due to the hormonal changes after menopause and occupational exposure to nickel.

Overweight, obesity and lipid abnormalities are the major risk factors for MS. In addition, overweight and MS increase the risk to diabetes and cardiovascular disease mortality, leading to a heavy disease burden among occupational workers, in the whole society as well[10]. Cardiovascular disease is the leading cause of death in China[3]. The disease burden among nickel-exposed workers is likely to increase in the near future unless effective measures are taken for the prevention and control of MS and overweight. In conclusion, the prevalence of MS, BMI≥25, and abnormal lipid is high in Chinese nickel-exposed workers, which may increase the risk to cardiovascular diseases and other non-communicable diseases. Public health programs should be strengthened to further prevent the prevalence of MS and overweight.

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