Hypertension risk and conventional risk factors in a prospective cohort study in Iran: The Persian Gulf Healthy Heart Study ☆

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About 50 percent of the burden of diseases in low and middle income countries is attributable to non-communicable diseases (NCD) from which ischemic heart diseases and stroke are among main contributors. Hypertension is a leading well-known risk factor for both conditions [1].

Many risk factors have been investigated in association with hypertension as an outcome [2]. However, few prospective studies in developing countries have been done to investigate the association between these risk factors and the development of hypertension.

The objective of this population-based, prospective study was to investigate the association between conventional risk factors and the 6-year risk of hypertension in a southern Iranian province, Bushehr.

The design and rationale for the Persian Gulf Healthy Heart Project (PGHHP) have been described in detail elsewhere [3].

Participants who had a systolic/diastolic blood pressure higher than or equal to 140/90 mm Hg or took antihypertensive medicine at the time of interview due to a previous diagnosis of hypertension were considered hypertensive.

The 6-year risk of hypertension was calculated as the proportion of participants who had hypertension in the second phase given that they were diagnosed as normotensive in the first phase.

The crude odds ratios were calculated as the cross-product of 2*2 contingency tables between the risk of hypertension and the risk factors. In addition, the associations between the risk of hypertension and age, sex, education level, smoking, obesity, hyperlipidemia, and DM at the baseline were examined using a multivariable logistic regression model.

A total of 3735 participants with a mean age of 40.4 ± 11.7 in the first phase and 1833 participants (49.1%) with a mean age of 47.2 ± 10.6 were included in this analysis. The number and characteristics of participants in the two phases are shown in Table 1.

The 6-year risk of hypertension was 16.9% (95% CI 14.9%–19.0%). The association between the risk of hypertension and demographic and conventional risk factors is shown in Table 2. A statistically significant linear trend for the risk of hypertension was seen as the number of main risk factors (obesity, smoking, hyperlipidemia, and DM) increased ($P < 0.001$).

The 6-year risk of hypertension was positively associated with age, overweight and obesity, and hyperlipidemia, but not with sex, education level (except for primary school), smoking, or DM after adjusting for potential confounding factors.

The 6-year hypertension risk was higher in overweight and obese participants than in those with a normal BMI when controlling for potential confounders. This finding is consistent with mostly cross-sectional studies carried out in Iran [4] and other parts of the world [5]. However, Juonala et al. reviewed four prospective studies and found that the risk of hypertension in obese adults who were not obese in childhood was similar to that of non-obese adults [6]. Although obesity has been known to be a major cause of hypertension in many prospective studies, the mechanism for this association is very complex, and many questions remain to be answered.

In the present study, hyperlipidemia was also associated with the risk of hypertension. Hyperlipidemia, both alone and accompanied by hypertension, has been recognized as a risk factor for cardiovascular diseases, but there is not much evidence indicating that hyperlipidemia is a risk factor for hypertension. However, the mechanisms through which hyperlipidemia affects cardiovascular outcomes and hypertension may be similar.

Smoking was not positively associated with the risk of hypertension in the present study. Although smoking has been recognized as a potent risk factor for major advanced cardiovascular events, few large longitudinal reports are available on the association between smoking and the resulting development of hypertension. Moreover, the literature on this association is controversial, and at times, even conflicting. Although some studies have shown that smoking is an independent risk factor for hypertension [7], others have failed to confirm this relationship [8]. In a prospective cohort study in Turkey, Onat et al. reported that smoking plays a protective role in lowering one's hypertension risk. They concluded that smoking plays this role by modifying the effect of weight on hypertension [2]. Further studies are needed to unveil the nature and mechanism of the association between smoking and hypertension.

DM and hypertension are known to be closely associated, but in this study, diabetic and non-diabetic participants' 6-year risk of hypertension did not differ after controlling for potential confounders, particularly for obesity as the most powerful confounder of the relationship. DM and hypertension have been shown to cross-predict each other [9], indicating

Table 1
Baseline characteristics of participants; the Persian Gulf Healthy Heart study.

		Phase I	Phase II
Participants (*n*)	Bushehr	2092	1092
	Deilam	594	351
	Genaveh	1049	390
	Total	3735	1833
Age (Mean (SD))		40.4 (11.7)	47.2 (10.6)
Sex (M/F)		1752/1983	823/1010
Married (%)		85.8	88.7
Crude hypertension rate (%)		26.2	29.9

☆ All authors take responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.

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Table 2
Association of conventional risk factors and 6-year risk of hypertension, the Persian Gulf Healthy Heart Study, Bushehr.

Risk factor		Crude OR (CI)	Adjusted OR (CI)	Adjusted variables
Age (years)	25–34	1	N/A	None
	35–44	2.26 (1.56–3.28)	N/A	None
	45–54	3.05 (2.04–4.56)	N/A	None
	55–64	3.94 (2.23–6.96)	N/A	None
	≥65	5.52 (2.67–18.35)	N/A	None
Sex (M/F)		1.25 (0.94–1.67)	N/A	None
Education level	Academic	1	N/A	N/A
	High school	0.67 (0.43–1.03)	0.74 (0.47–1.16)	Age, sex
	Guidance school	0.64 (0.39–1.04)	0.68 (0.41–1.13)	Age, sex
	Primary school	0.62 (0.39–0.99)	0.49 (0.29–0.83)	Age, sex
	Illiterate	1.77 (1.09–2.87)	1.43 (0.75–2.71)	Age, sex
Obesity[1]	BMI < 25	1	N/A	N/A
	BMI = 25–29	1.46 (1.03–2.07)	1.51 (1.06–2.16)	Age, sex, education level
	BMI ≥ 30	1.88 (1.28–2.75)	1.98 (1.31–3.06)	Age, sex, education level
Smoking[2]		1.09 (0.76–1.58)	0.73 (0.49–1.09)	Age, sex, education level
Diabetes mellitus[3]		2.11 (1.37–3.23)	1.34 (0.84–2.13)	Age, sex, education level, obesity, hyperlipidemia
Hyperlipidemia[4]		2.07 (1.44–2.98)	1.63 (1.11–2.37)	Age, sex, education level, obesity, diabetes mellitus
None		1	N/A	N/A
1 AND 2		1.80 (1.11–2.91)	1.27 (0.75–2.15)	Age, sex, education level
1 AND 3		2.85 (1.66–4.89)	2.11 (1.18–3.79)	Age, sex, education level
1 AND 4		3.00 (1.73–5.22)	2.66 (1.50–4.69)	Age, sex, education level
2 AND 3		1.45 (0.55–3.80)	0.57 (0.18–1.80)	Age, sex, education level
2 AND 4		2.13 (1.31–3.47)	1.34 (0.75–2.39)	Age, sex, education level
3 AND 4		3.71 (2.15–6.43)	2.78 (1.51–5.12)	Age, sex, education level
None		1	N/A	N/A
1 AND 2 AND 3		1.92 (0.71–5.23)	0.76 (0.22–2.59)	Age, sex, education level
1 AND 2 AND 4		3.93 (1.28–12.19)	1.20 (0.28–5.11)	Age, sex, education level
1 AND 3 AND 4		6.00 (2.85–12.63)	4.29 (1.83–10.03)	Age, sex, education level
2 AND 3 AND 4		2.74 (0.98–7.70)	1.11 (0.30–4.08)	Age, sex, education level
None		1	N/A	N/A
1 AND 2 AND 3 AND 4		4.76 (1.38–16.68)	2.65 (0.52–13.65)	Age, sex, education level

common metabolic pathways [10]. However, one explanation for the finding in the present study is the relatively short follow-up period.

As shown in Table 2, the coexistence of obesity, DM, and hyperlipidemia was accompanied by an increased risk of hypertension. The highest risk was seen for the simultaneous presence of all three risk factors. However, smoking is an exception. The presence of smoking modified the effects of other risk factors toward no association. As discussed earlier, despite substantive research in this area, the mechanisms through which these risk factors affect hypertension and interact with each other remain unclear and controversial.

Substantial attrition from phase 1 to phase 2 and a relatively short study period for investigating long-term effects of some risk factors such as smoking and DM are two important limitations of this study.

In summary, this prospective study is a step forward toward understanding the risk factors of hypertension in a developing country where few prospective studies have been conducted.

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