Preplanned Studies

Intervention of Hypertension by Occupational Health Management Among Dock Workers — Shenzhen City, Guangdong Province, China, 2020–2024

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Summary

What is already known about this topic?

Hypertension predisposes dock workers to higher health risks in their work environments, requiring urgent intervention via comprehensive health management.

What is added by this report?

This study explored occupational health management in hypertension among dock workers and found that occupational health management measures helped reduce the blood pressure of patients with hypertension, curb the incidence, and slow the growth rate of its prevalence.

What are the implications for public health practice?

The intervention measures adopted in this study should be promoted in similar occupational environments.

ABSTRACT

Introduction: Hypertension predisposes dock workers to high health risks in their work environments, requiring urgent intervention via comprehensive health management.

Methods: In 2020, 1,145 dock workers from Shenzhen, China, were enrolled via cluster sampling for an intervention trial over the following 4 years. Annual blood pressure (BP) monitoring and questionnaires regarding basic characteristics and work information were administered. The occupational health management measures for hypertension intervention included daily pre-shift BP monitoring and hierarchical management, regular health training, dietary management, and exercise promotion. Annual BP values and hypertension incidence and prevalence were analyzed to evaluate outcomes.

Results: The median age of the cohort was 46 years, with a median body mass index of 25.08 kg/m^2 at baseline. The median systolic and diastolic BP of patients with baseline hypertension were significantly reduced during the intervention period (all P<0.001), showing downward trends (both P_{trend}<0.001). The incidence of hypertension in the cohort showed a decreasing trend during the intervention period (P_{trend}<0.001). Although the prevalence of hypertension increased annually during the intervention (P_{trend}<0.001), its growth rate decreased annually.

Conclusion: These intervention measures helped control BP and reduce the incidence of hypertension in dock workers, which should be promoted in similar occupational environments.

Hypertension is the primary risk factor for cardiovascular and cerebrovascular diseases (*1*). Dock workers are generally older and are often exposed to occupational factors related to hypertension risk, such as high-intensity physical labor, shift work, noise, and psychological pressure. Multiple studies have shown that the prevalence of hypertension is significantly higher than in the general population (*2*–*3*). Moreover, hypertension predisposes dock workers to higher health risks in their work environments. Although the Chinese Guidelines for the Prevention and Treatment of Hypertension (CGPTH) emphasize the importance of comprehensive intervention (*4*), systematic health management research on the special occupational environment of seaports remains scarce. Therefore, this study evaluated occupational health management of hypertension among dock workers with the aim of providing a scientific basis for formulating targeted prevention and control strategies.

In early 2020, 1,200 dock workers were enrolled from a port company in Shenzhen, China, via cluster sampling. After 4 years of continuous health

intervention, 1,145 participants were included. The participant selection process is shown in Supplementary Figure S1 (available at https://weekly.chinacdc.cn/).

Blood pressure (BP) monitoring and health surveys were administered annually in the cohort from 2020 (baseline) to 2024. The survey questionnaire included questions regarding basic characteristics, occupational information, lifestyle, and medical history. Doctors and nurses evaluated the participants and diagnosed hypertension. According to the CGPTH, the diagnostic criteria for hypertension were systolic blood pressure (SBP) ≥140 mmHg and/or diastolic blood pressure (DBP) ≥90 mmHg.

The occupational health management interventions were as follows:

First, hierarchical management by pre-shift BP: Study participants measured their BP daily before going on duty and were managed hierarchically according to the results. Participants with SBP<120 mmHg and DBP<80 mmHg (normal BP) could continue to work in their current positions; those with SBP≥120 mmHg but <140 mmHg or DBP≥80 mmHg but <90 mmHg (high-normal level) were required to complete daily health education by watching videos; and those with SBP≥140 mmHg or DBP≥90 mmHg (hypertension) were temporarily restricted from high-risk operations on that day and were referred for medical intervention.

Second, regular health training: On-site training lectures were held quarterly, covering the hazards of hypertension, reasonable diet (low-salt and low-fat), regular exercise, and stress management.

Third, dietary and exercise intervention: The on-site canteen provided low-salt healthy food options and established dietary health education boards. The labor union organized work-break exercises, walking competitions, and built fitness areas.

Uniformly trained investigators guided the participants in completing the questionnaires. Pre-shift BP monitoring and hierarchical management were supervised by the company's occupational health management personnel and enforced among all participants. Regular health training, dietary management, and exercise promotion were organized by the company's labor unions and were mandatory for all participants.

R Statistical Software (version 4.3.3, R Development Core Team, Vienna, Austria) (5) was used for data analysis. The *Wilcoxon* signed-rank test was used for between-group comparisons of BP. The *Pearson* χ^2 test (or *Fisher*'s exact test) and McNemar's test were used for between-group comparisons of incidence and prevalence, respectively. Linear regression was used for BP trend analysis, and the Cochran-Armitage trend test was used for incidence and prevalence trend analysis. The priori α significance level was set at $P<0.05$.

As shown in Table 1, the cohort had a median age of 46 years at baseline. They were primarily male (97.6%), married (91.0%), and Han Chinese (95.7%). The median body mass index (BMI) was 25.08 kg/m^2, indicating that more than half of the study population was overweight, according to the World Health Organization (WHO) criteria. Those who smoked, used alcohol, and regularly exercised accounted for 23.4%, 12.2%, and 45.2% of the participants, respectively. The median time of employment was 12 years.

The median SBPs of the cohort at baseline and during the intervention were <130 mmHg, but the median DBPs were ≥80 mmHg (Table 2). According to the American Heart Association criteria, more than half of the cohort required long-term intervention. Although the median BP showed small fluctuations during the intervention and slightly increased compared with the baseline level in some intervention periods (Table 2), the median BP at all time points was lower than the hypertension diagnostic criteria of China and the WHO (6).

Table 2 shows that the median SBP and DBP of patients with baseline hypertension during the intervention were all lower than the hypertension diagnostic criteria. Compared with the baseline level in 2020, the SBP of patients with baseline hypertension in 2021–2024 decreased significantly (V=23,702, $P<0.001$, V=19,975, $P<0.001$, V=25,853, $P<0.001$, and V=27,738, $P<0.001$, respectively), and the DBP in 2021–2024 decreased significantly (V=19,972, $P<0.001$, V=24,386, $P<0.001$, V=26,636, $P<0.001$, and V=30,696, $P<0.001$, respectively), and both SBP and DBP showed significant downward trends with the extension of the intervention time ($\beta=-2.32$, $P_{trend}<0.001$, and $\beta=-2.66$, $P_{trend}<0.001$, respectively).

Compared to the baseline level in 2020, the SBP and DBP of participants without baseline hypertension slightly increased in 2021–2024 (Table 2). However, the median SBP and DBP of participants without baseline hypertension during the intervention were lower than the diagnostic criteria for hypertension.

The incidence of hypertension in the cohort showed

TABLE 1. Baseline characteristics of the cohort (*n*=1,145).

Characteristics	*N* (%)
Age (years)	
≤30	104 (9.1)
31–40	250 (21.8)
41–50	502 (43.8)
≥51	289 (25.2)
Sex	
Male	1,118 (97.6)
Female	27 (2.4)
Ethnicity	
Han	1,096 (95.7)
Others	49 (4.3)
Marital status	
Married	1,042 (91.0)
Others	103 (9.0)
Education	
Junior high school or lower	560 (48.9)
High school or technical secondary school	439 (38.3)
College or higher	146 (12.8)
Body mass index (kg/m^2)	
<18.5	16 (1.4)
18.5–23.9	373 (32.6)
24.0–27.9	552 (48.2)
≥28.0	204 (17.8)
Smoking	
Current smoker	268 (23.4)
Never or occasional smoker	417 (36.4)
Former smoker	460 (40.2)
Alcohol use	
Current alcohol user	140 (12.2)
Non- or occasional alcohol user	613 (53.6)
Former alcohol user	392 (34.2)
Regular exerciser	
Yes	518 (45.2)
No	627 (54.8)
Job type	
Loading and unloading driver	280 (24.4)
Tally clerk	214 (18.7)
Repair worker	93 (8.2)
Others	558 (48.7)
Time of employment (years)	
1–10	497 (43.4)
11–20	477 (41.6)
≥21	171 (14.9)

Note: Current smoker refers to an individual who smoked at least 1 cigarette per day and continued for 6 months or longer before the survey; occasional smokers refer to individuals who reported smoking within 6 months before the survey but did not meet the criteria for current smoker; and former smoker refers to an individual who smoked before but did not smoke within 6 months before the survey.
Current alcohol user refers to an individual who drank at least 1 alcohol beverage 1 time per week and continued for 6 months or longer before the survey; occasional alcohol user refers to an individual who reported alcohol consumption within 6 months before the survey but did not meet the criteria for current alcohol user; and former alcohol user refers to an individual who drank before but did not drink within 6 months before the survey.
Regular exerciser was defined as a person who engaged in at least twice per week of ≥30 min moderate-intensity (causing accelerated breathing and heart rate) physical activity and continued for 6 months or longer before the survey.

TABLE 2. Comparison of blood pressure at baseline and during the intervention period.

Cohort	Year	Systolic blood pressure			Diastolic blood pressure		
		Value [mmHg, *M* (P_{25}, P_{75})]	Statistics	*P**	Value [mmHg, *M* (P_{25}, P_{75})]	Statistics	*P**
Total (*n*=1,145)	2020	126.0 (116.0, 136.0)			80.0 (73.0, 88.0)		
	2021	126.0 (116.0, 136.0)	282,202	1.000	84.0 (76.0, 89.0)	202,923	<0.001
	2022	128.0 (118.0, 137.0)	235,506	<0.001	82.0 (75.0, 88.0)	248,110	<0.001
	2023	127.0 (118.0, 136.0)	265,700	0.108	81.0 (75.0, 87.0)	276,620	1.000
	2024	128.0 (118.5, 136.0)	287,931	0.316	81.0 (74.0, 86.0)	327,424	0.004
Baseline hypertensive patients (*n*=255)	2020	143.0 (136.0, 150.0)			94.0 (90.0, 98.0)		
	2021	136.0 (128.0, 143.0)	23,702	<0.001	90.0 (85.0, 97.0)	19,972	<0.001
	2022	139.0 (130.5, 148.0)	19,975	<0.001	88.0 (83.0, 95.0)	24,386	<0.001
	2023	134.5 (127.0, 139.0)	25,853	<0.001	87.0 (82.0, 90.0)	26,636	<0.001
	2024	135.0 (128.0, 139.0)	27,738	<0.001	85.0 (78.5, 89.0)	30,696	<0.001
Baseline non-hypertensive participants (*n*=890)	2020	122.0 (114.0, 129.0)			77.0 (72.0, 83.0)		
	2021	123.0 (114.0, 133.0)	133,660	<0.001	81.0 (75.0, 87.0)	86,335	<0.001
	2022	125.0 (117.0, 134.0)	110,024	<0.001	80.0 (74.0, 86.0)	104,478	<0.001
	2023	125.0 (116.0, 133.0)	112,166	<0.001	80.0 (73.0, 86.0)	114,304	<0.001
	2024	125.0 (117.0, 134.0)	122,374	<0.001	79.0 (72.0, 85.0)	134,842	<0.001

* Compared with baseline levels in 2020 and adjusted using the Bonferroni method for multiple comparisons.

a decreasing trend during the intervention period (Z=−8.16, P_{trend}<0.001). Compared with 2021, the hypertension incidence in 2023–2024 decreased significantly (χ^2=53.32, *P*<0.001 and χ^2=47.40, *P*<0.001, respectively); compared with 2022, the incidence in 2023–2024 also decreased significantly (χ^2=44.04, *P*<0.001 and χ^2=38.80, *P*<0.001, respectively) (Table 3).

The prevalence of hypertension significantly increased each year in 2021–2023 when compared with the previous year (all *P*<0.05), but it was not significantly different between 2023 and 2024. Although the hypertension prevalence in the cohort showed an increasing trend during the intervention period (Z=−13.33, P_{trend}<0.001), its rate of increase decreased annually (Table 3).

DISCUSSION

This study explored occupational health management as an intervention for hypertension among dock workers. The results showed that systematic occupational health management might confer dual benefits for the prevention and control of hypertension in dock workers: it could effectively control the BP of patients and reduce the risk of new-onset hypertension. First, patients with hypertension may benefit significantly. The baseline BP of patients with hypertension dropped below the diagnostic criteria (Table 2), which may be directly related to pre-shift BP monitoring, hierarchical referral, and continuous health management. Daily monitoring helps achieve early detection and intervention, avoiding further increases in BP. Second, the incidence of hypertension in the cohort decreased, and the growth rate of its prevalence slowed. Health training, exercise, and dietary interventions may improve health awareness, and the incidence in the last 2 years of intervention was significantly lower than that in the first 2 years (all *P*<0.001) (Table 3), indicating that the intervention could reduce the risk of new-onset hypertension. Although population aging might increase the prevalence of hypertension, the intervention reduced the growth rate (annual growth rate decreased from 50.7% to 4.4%) (Table 3), suggesting that management measures might partially offset age-related risks and slow the growth rate of the disease.

The small fluctuations and increases in the median BP of the cohort during some intervention periods may be attributed to aging. As the intervention time increased, the median age of the cohort increased from 46 to 50 years, and age is an independent risk factor for BP elevation (7). Although the intervention reduced the BP of patients with hypertension, the BP of participants without hypertension increased slightly

TABLE 3. Incidence and prevalence of hypertension at baseline and during the intervention period.

Year	Incidence			Prevalence		
	Rate (%)	Statistics	*P*	Rate (%)	Statistics	*P*
2020				22.45		
2021	14.64			33.83	243.56	<0.001*
2022	13.45	0.38	1.000†	42.88	168.81	<0.001*
					66.14	<0.001†
2023	3.25	53.32	<0.001†	45.22	146.83	<0.001*
		44.04	<0.001§		52.14	<0.001†
					14.69	0.001§
2024	3.59	47.40	<0.001†	47.23	83.78	<0.001*
		38.80	<0.001§		43.15	<0.001†
		0.03	1.000¶		10.06	0.020§
					6.28	0.122¶
	Trend	−8.16	<0.001	*Trend*	−13.33	<0.001

Note: *P* values were adjusted using the Bonferroni method for multiple comparisons;
* Compared with the rate in 2020;
† Compared with the rate in 2021;
§ Compared with the rate in 2022;
¶ Compared with the rate in 2023.

(Table 2), probably due to increasing age, thus leading to fluctuations and slight increases in the median BP of the entire cohort (Table 2).

The findings of this study have at least three limitations. First, it was not a randomized controlled trial; thus, accurately evaluating the effect of the management measures was impossible. Second, the dock worker population was mainly male, which limited the extrapolation of the intervention effects to females. Finally, this study did not evaluate the cost-effectiveness of the intervention measures, which might limit their application and promotion.

In conclusion, this study demonstrated that an occupational health management strategy for dock workers could significantly reduce the BP of patients with hypertension, effectively decrease the growth in incidence, and slow the rate of prevalence, which seems worthy of application and promotion in similar occupational environments. Based on these findings, we recommend incorporating daily pre-shift BP monitoring into relevant regulations to better protect the health of dock workers. Public health professionals should develop related health guidelines and establish a screening-referral loop with evaluations. Dock workers should actively participate in monitoring and health training, follow management arrangements, and adopt healthy diets and exercise.

Ethical statement: Approved by the Medical Ethics Committee of the Shenzhen Prevention and Treatment Center for Occupational Diseases (*Approval No.* LL2020-34), in accordance with the 1975 Declaration of Helsinki and its later amendments or comparable ethical standards. Written informed consent obtained from all the participants or their legal guardians.

Conflicts of interest: No conflicts of interest.

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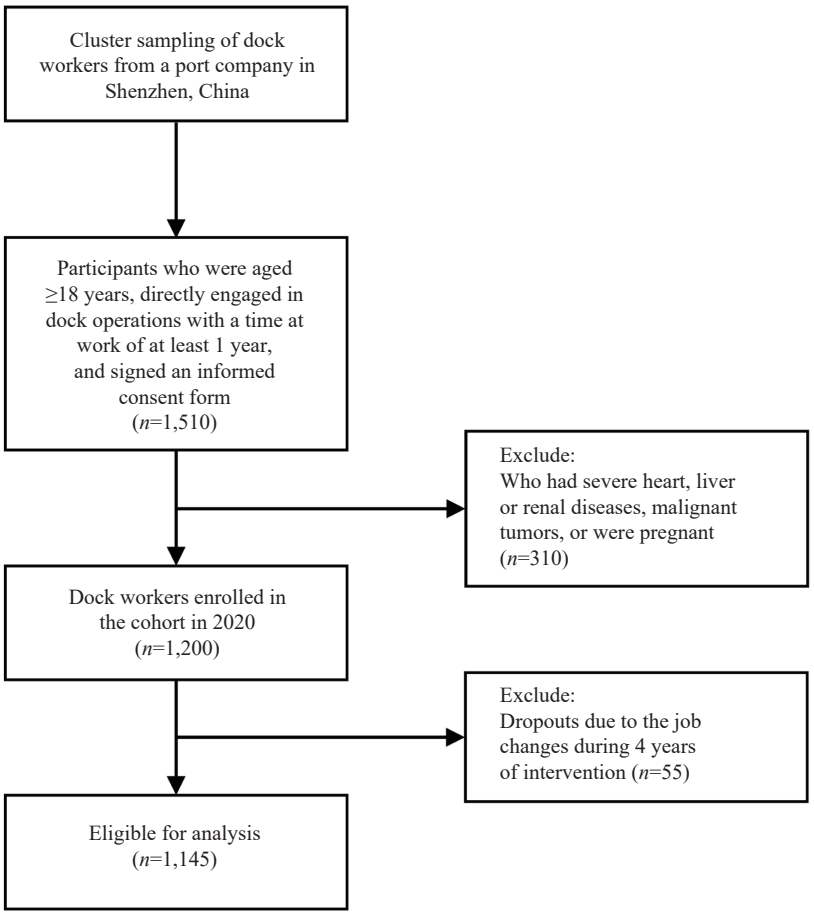
SUPPLEMENTARY MATERIAL



SUPPLEMENTARY FIGURE S1. Flowchart for participants selection.