

## Cardiovascular Risk for Workers in Big, Infrastructure Projects

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### Abstract

**Objectives:** The objective of our study is to evaluate in infrastructure projects workers which working risk factors and styles of life represent a major risk factor for arterial hypertension which, in turn, significantly increases cardiovascular risk.

**Methods:** 257 workers were subject to three investigation instruments, following the French ESTEV methodology, modified in Italy by Barbini and Squadroni and later by Barbini, Bigger; one questionnaire was on professional conditions, one on the styles of extra work life, and was a medical questionnaire to obtain the objective health conditions of the workers.

**Results:** Arterial hypertension is present in 139 subjects, equaling to 54% of the sample. The distribution of frequency of arterial hypertension is greater in the class of drivers, followed by the class of site managers and construction machines/excavator drivers.

**Discussion and conclusion:** It is believed that the risk factors to which the workers studied are exposed, constitute elements that facilitate the onset of a state of arterial hypertension; among these, the stress correlated to a task which requires, lengthened attention and concentration, resulted as being the most important factor (OR=3.71).

**Keywords:** Hypertension; Risk; Stress; Work

### Introduction

Arterial hypertension is considered a very important risk factor for the development of cardio and cerebral-vascular pathologies [1-4], and is one of the disorders with the highest prevalence in advanced age [5,6]. In Italy, 31% of the general population suffers from hypertension and 17% is borderline [7].

Few studies have examined the relationship between work and health state, especially considering prolonged working life and the presence of always older subjects at work [5,6]. Some studies considering these factors have shown a high frequency of arterial hypertension in specific working groups [2]. But independently from age and other extra professional risk conditions, some work conditions are associated to a high risk of developing arterial hypertension [8-11]. In some studies, arterial hypertension has been associated more frequently with "blue collars" than with "white collars" [12], a positive association is also present in bus and taxi drivers [13], meaningfully higher compared to mechanical maintenance technicians [14]. Workers with exposition to noise superior to 85 dB (A) for longer than 30 years have shown a risk of hypertension 1.5 times higher [15,16].

Among the professional factors clearly associated with an excessive risk of arterial hypertension we find work organizational constrictions [3] and studies dealing with the subjective evaluation of workers regarding their own work and work organization rather than with traditional risk factors, are becoming more numerous [1,9,17,18].

The association found between prolonged work and risk of acute coronary disease [19,20], could be explained with an excessive activation of the sympathetic nervous system and a rise in arterial pressure levels, together with a reduced activation of the parasympathetic system which in turn, constitutes a risk factor for CHD [21]. After all, arterial hypertension has been associated with work correlated stress [22], a situation that is notoriously associated to an activation of the adrenergic system, to extended work time [23] and shift work [3].

The workers examined are occupied in the building sites of the big, infrastructure projects, among which the Alta Velocità (TAV),

an internationally relevant work, in the line Bologna - Florence line, Tuscan side, the construction of the highway variant on the Barberino - Florence line. Work and life conditions are the same: the majority is immigrant, commuters, who live most of their extra working life far from their family, friends and birthplace, lodged in base camps far from residential areas. Having considered the working conditions and the lifestyles of these workers, we can hypothesize that they can frequently run into stress situations which could induce the increase of arterial pressure.

The study has the objective of examining the occurrence of arterial hypertension and which variables, among the risk factors and lifestyles, are most frequently associated with this pathological condition in these workers.

### Methods

The methodology used derives from an Italian inquiry about aging, health and work [3], which in turn had emulated the methodology of ESTEV (Enquete Santé, Travail et Vieillessement) [1] and VISAT (Vieillessement, Santé, travail) [9] investigations conducted in France [1] during the 90s. 3 survey methods have been planned and created: 1 questionnaire on the professional conditions of the workers, 1 questionnaire on the extra working life styles, 1 medical questionnaire for the collection of data about the objective health conditions of the

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workers. In total, the questionnaires include 86 items with simple or multi answer, according to the inquiry necessities, 9 items are made of open questions. The questionnaires were handed out to 257 workers during an interview in the infirmary of the base camp generally during working time. After the interview, biometric parameters were determined: height, weight and waist circumference. Arterial pressure, obtained after about 30 minutes after the end of the working shift, was measured in clinostatic position, measuring it three times and using the average value obtained. Subjects considered high-blood pressure sufferers presented values of systolic arterial pressure higher than 140, and/or a diastolic pressure equal or higher than 90 mmHg, following the criteria indicated by the WHO.

The questionnaires represent a smaller version of the questionnaire validated and used in Italy in 2000 for the inquiry carried out on more than 3000 workers which in turn, derived from the questionnaire validated and used in France for the inquiry carried out on more than 23000 workers [1,9].

## Results

### Characteristics of the sample

The workers, subjects of the study are 257, all male. The average age of the workers corresponds to 45 years and they result in having high working seniority, since the average age at first employment was 16.

92 workers are in charge of the tunnel whereas the workers in charge of the external works are 158. Regarding age, the sample was divided into 2 groups with a cut-off at 45 and it was seen that a little over half surpassed this threshold (Table 1), but while 64.1% of the workers in the tunnel is older than 45, in the external activities there is a younger population, with 51.9% aged up to 45 years included.

### Uses and habits

Concerning the lifestyles and some habits, these data are presented in Table 2. According to the data, nearly ¼ of the sample lives alone. The majority of the interviewed, 72% lives in the base camp. About the 80% employs more than three hours to travel to their family, 39% more than 6. Only 28% does physical activity. It must be considered that almost all activities related to free time (DIY, cultural and social, gardening) are performed when the workers can return to their domestic environment which is every 3 weeks, so they are carried out sporadically. Concerning luxury habits, 46% of the workers smoke, 24% don't and 30% of the workers are ex-smokers.

### Professional conditions

The majority of workers seem to work as carpenters/solderers (41%) and drivers (16%) of machines/excavators. Miners represent 6% of the sample, but the workers that operate inside the tunnels are in total 36% of the group. In reference to the work effort, it was observed that the workers examined work on average almost 47 hours a week, however 2/3 of the sample (77%) works more than 48 hours a week. Data about the characteristics of the working task carried out can be seen in Table 3.

Concerning the perception of characteristics of one's own job, the data is presented graphically in Table 4. Workers were asked to express the sense of satisfaction towards their job through the use of a Likert scale with 10 gradual values, from 0 (very satisfying) to 10 (not satisfying at all). 22% of the sample judged their work as very satisfying and the majority of workers positioned their choice on value 5, intermediate, indicating that the negative aspects of their condition (heavy and tiring

work, high risks, distance from home...) were partly counterbalanced by some positive aspects (qualified work, sufficiently remunerated...). The workers indicated in 83% of the cases that the profession carried out is a result of a motivated and fulfilling choice.

## Health Conditions

### Biometric parameters

The average height of the workers is 173.9 cm. The average weight is 80.9 kg. The body mass index is in average 26.7. The circumference at waist level measures 95.3 cm. The data presented in Table 5 was gathered through the questionnaire on health conditions.

There it can be observed that only 9% of the sample declares to have had after-effects linked to injuries or severe traumas. 45.1% of the workers was absent from work due to illness or accident, thus had interrupted their work during the last twelve months, in the majority of cases for a period of absence of 8-15 days or for absences of more than 30 days (in both cases with values of 13%).

### Encountered pathologies

The prevalent pathological condition has resulted as being arterial hypertension, which was found in more than half of the interviewees, exactly 54% of them, in 39.6% of the tunnel workers and in 58.3% of those working outside. 75.5% of the hypertensive subjects lived in the base camp, while 24.5% lived nearby and could go back home daily.

Table 6 presents the absolute distribution and percentage of the hypertensive state in the main professions examined. Drivers show a very high prevalence of arterial hypertension (80%), followed by operators, miners, carpenters/solderers and drillers, all with a prevalence of hypertension higher than 50%. Considering in the first place the age variable, since in literature the relation between arterial hypertension and age increase has been widely demonstrated, the workers were divided into two groups, one up to 45 years, the other one over 45 years, to be able to evaluate how age can influence the onset of this pathology (OR 0.29, IC 0.17-0.49) in a statistically significant way. Table 7, which shows the results coming from the bivariate analysis, through a table of contingency, related to the presence of arterial hypertension and to some variables considered, to test likely risk factors.

From Table 7, in which are shown the results obtained in the associations with some working characteristics, it can be observed that working inside the tunnel, rather than outside, is not significantly associated with the presence of hypertension. Several working conditions are associated with arterial hypertension, nevertheless, some of these record a higher risk probability, like for example a task

Age	n.	%
18-45	118	45.9
46-67	139	54.1
Marital status		
1. Married	177	68.9
2. Single	80	31.1
Educational qualification		
1.Elementary	41	16
2.Junior high	152	59.10
3.Junio highschool	44	17.1
4. Professional diploma	14	5.4
5. University	6	2.3

Table 1: Socio-demographic characteristics of the studied population.

	N.	%
<b>Lives</b>		
In the base camp	186	72.4%
In a village close to the working place	56	21.8%
Other	14	5.4%
<b>Lives Alone?</b>		
No	186	72.4%
Yes	70	27.2%
<b>Smoke</b>		
Non smoker	61	23.7%
Ex smoker	77	30.0%
smoker	119	46.3%
<b>Sport activity</b>		
Yes	73	28.4%
No	183	71.2%
<b>Do-it-yourself activities</b>		
Yes	98	38.4%
No	157	61.6%
<b>Cultural activities</b>		
Yes	46	18.0%
No	210	82.0%
<b>Social activities</b>		
Yes	35	13.7%
No	220	86.3%
<b>Gardening</b>		
Yes	105	40.9%
No	152	59.1%
<b>Television</b>		
Yes	239	93.4%
No	17	6.6%
<b>Alcohol</b>		
Non drinker	130	50.6%
Drinker	127	49.4%
<b>How much time is needed to travel home to their family?</b>		
0-less than 3 hours	53	20.7%
3-5 hours	102	39.8%
6-8 hours	50	19.5%
More than 8 hours	51	19.9%

**Table 2:** Lifestyles.

that *requires prolonged attention and concentration*, a condition for which risk increases more than 4 fold (OR 4.82).

Arterial hypertension risk is very high in relation to shift work (OR 2.78), sleeping in irregular patterns (OR 2.76), eating in irregular patterns (OR 2.62), night shifts (OR 2.55), not being able to turn the eyes away from one's task (OR 2.50), work strain on instruments and machines (OR 2.46).

The biometric parameters able to influence arterial hypertension were evaluated. Considering as a risk factor waist circumference superior to 94 cm, it has been seen that there is a statistically significant association between this variable and the presence of hypertension (OR 2.84, IC 1.71-4.73). Hence, as demonstrated in literature [24], a condition of obesity represents a significant risk factor for the pathology studied, as in the group of examined workers, were having a waist circumference equal to or higher than 94 cm increases the risk of hypertension by 2.8 times. This element is confirmed also if the body mass index is considered: in fact, to a value of BMI higher than 25 corresponds an analogous estimate of risks, with OR 2.88, IC 1.7-4.89. Basically, in this group of workers, the condition of overweight is able

to augmenting of 3 fold the risk of becoming hypertensive.

In order to further address risk factors for the insurgence of arterial hypertension, the association with extraprofessional parameters was studied (Table 8).

Based on the variables that have showed higher statistical significance in the associations carried out, we proceeded to estimate the risks through multivariate analysis, with models of logistic regression. Table 9 shows the data on multivariate analysis, checked for the age variable (subject aged less than 45 years vs. subjects aged equal to or over 45 years).

In the considered items in Table 9, a decrease of the value of ORs compared to the values of rough ORs present in Table 7 is observed, however a statistically significant risk remains for the variables better examined, particularly for what concerns work that requires a prolonged attention and concentration (OR 3.71).

In order to evaluate an additive value of the risk determinants, during the phase that followed the analysis, we created a model of logistic regression containing all the variables that had resulted as being

	YES		NO	
	n.	%	n	%
Works often more than 48 hours/week?	197	76.7	60	23.3
Work shifts?	192	74.7	65	25.3
Night shifts?	185	72.0	72	28.0
Lifts weights heavier than 5 kg?	199	77.4	58	22.6
Makes physical strain on equipment?	186	72.4	71	27.6
Is exposed to loud noise?	205	79.8	52	20.2
Is exposed to high temperatures?	186	72.4	71	27.6
Is exposed to weather conditions?	212	82.5	45	17.5
Is exposed to dusts and/or smoke?	213	82.9	44	17.1
Is exposed to chemical compounds?	181	70.4	76	29.6
Is often required to rush?	183	71.2	74	28.8
Required to do different things than the assigned task?	181	70.4	76	29.6
Required to take care of inferior or superior tasks than the assigned task?	181	70.4	76	29.6
Is often interrupted during work?	198	77.0	59	23.0
Job requires prolonged attention and concentration?	234	91.1	23	8.9
Can't avert eyes from job?	202	78.6	55	21.4
Is often required to maintain balance in dangerous situations?	183	71.2	74	28.8
Has often to work on Saturday and Sunday?	181	70.4	76	29.6
Has to sleep in irregular patterns?	176	68.5	81	31.5
Has to eat in irregular patterns?	182	70.8	75	29.2

**Table 3:** Working characteristics of the study population.

On the other hand, would you say that your current job presents the following characteristics?				
	Yes		No	
	n	%	n	%
Can you choose how to proceed?	163	63.4	94	36.6
Do you have the means to do a quality job?	236	91.8	21	8.2
At the present time, if you desired, would it be possible to change the task inside your working place?	99	38.5	158	61.5
Do you consider yourself able to carry on with the current tasks until retirement?	228	88.7	29	11.3
The degree of responsibility assigned is satisfying?	237	92.2	20	7.8
Altogether, would you consider that your job is appreciated by your colleagues?	240	93.4	17	6.6
Altogether, would you consider that your job is appreciated by your superiors?	241	93.8	15	5.8
In relation to your parents, do you think you have a professional situation:				
More favourable	143	55.6		
More or less equivalent	86	33.5		
Less favourable	26	10.1		

**Table 4:** Perception of the working characteristics in the studied population.

more significant in the overexposed associations. From these models no risk increments originated and a loss of statistical significance in associations was found. Therefore the weight of the various determinants is to be considered individually.

## Discussion and Conclusion

While examining the given data, some peculiar characteristics of the sample of workers included in the study emerge. Firstly, it's about workers who are all male, mainly over 45 with a medium-low level of education.

72% of the sample lives in the base camp, alone, thus far from their family and returns home in average once every three weeks. These conditions predisposes permanence at work over the 40 weekly hours, in fact 3 workers out of 4 declare to work much more than 48 hours a week. Life in base camp is spent between work, business canteen meals, television and socialization with work colleagues, with limited

chance of practicing sports. 46% of the sample smokes habitually and 49% drinks hard liquors and these habits have been object of attention during our analysis, seeing that the interest field of the whole study is, primarily centered primarily on cardio-vascular pathologies.

Imposition of frequent rhythms, the high level of concentration and attention, the high danger intrinsic of the tasks and the working environment, being interrupted during one's work or carrying out several tasks simultaneously (characteristics declared by 3 workers over 4) produce effects on the cardiovascular system. The irregularity of meal times and sleep times disturbs biological circadian rhythms.

It must be highlighted that even if the examined workers have to face risks and obligations related to work typology, it is clear that other factors could play a compensating role, among these it is worth mentioning *satisfaction for the assigned degree of responsibility or appreciation by superiors for the work performed*. In fact, as some studies have shown, these elements, added to a certain degree of decisional

	No		Yes	
	n.	%	n.	%
Do you have after effects related to severe injuries or traumatisms?	128	49.8	22	8.6
Have you had an occupational disease?	227	88.3	27	10.5
<b>During the last twelve months, did you have to interrupt work for:</b>				
Illness	166	64.6	91	35.4
Accident/Injury	225	87.5	31	12.1
Surgery	239	93.0	17	6.6
<b>In total during the last twelve months, how many interruptions did you have from work for illness and/or accident:</b>				
None	140	54.5		
1	78	30.4		
2	27	10.5		
3	6	2.3		
4 or more	5	1.9		
<b>In total, how many days of interruption has this entailed?</b>				
No days	141	54.9		
1-3 days	6	2.3		
4-7 days	19	7.4		
8-15 days	34	13.2		
16-30 days	23	8.9		
Più di 30 days	34	13.2		
<b>Hypertension</b>	<b>118</b>	<b>45.9</b>	<b>139</b>	<b>54.1</b>

**Table 5:** Objective health conditions.

Task	N. Workers	Yes		No	
		n.	%	n.	%
Driver	15	12	80	3	20
Miner	16	9	56.25	7	43.75
Metalmeccanic	17	5	29.41	12	70.59
Machinery driver	42	27	64.29	15	35.71
Carpenter/solderer	106	59	55.66	47	44.34
Driller...	13	7	53.85	6	46.15
Employee	4	0	0.00	4	100.00
Surveyor	2	1	50.00	1	50.00
Topographer	2	0	0.00	2	100.00
Safety personnel	2	1	50.00	1	50.00
Warehouse worker	5	2	40.00	3	60.00
Electrician	7	4	57.14	3	42.86
Site manager	12	8	66.67	4	33.33

**Table 6:** Presence of arterial hypertension in the different professions.

autonomy (63% declares of being able to choose the method to proceed) would be able to compensate and counterbalance the fatigue of the job and enable the worker to carry on their task for a long time. In fact, it is observed in our sample how, considered the declared tasks, 88% of the workers feels able to carry out their job until retirement.

Focusing on the task carried out, we observed that the majority of workers conducts performs highly technological manual jobs which require also a lot of attention and precision. These activities also require also the prolonged maintenance of uncomfortable postures with important physical strain, which can stress one or more osteoarticular segments, with a particular overload for the rachis. Considering that the tasks are without doubt demanding both from the physical and the cognitive point of view, it is understandable that 45% of the sample has had to interrupt work, due to illness during the twelve months preceding the interview.

Considering the objective health conditions, it has emerged that the main pathological condition is arterial hypertension. In fact this condition is present among more than half of the workers, but in particular among those who conduct the profession of driver, similarly to what has been described in the literature for bus drivers [13], site managers, exposed to high levels of stress due to the large amount of responsibility, and construction machinery drivers, whose concentration and attention is considerably strained, due to the intrinsic danger of the task.

Age seems to have an important role for this pathology, as confirmed by the literature data [5,6]. In fact, the subjects older than 45 years have an increased hypertensive risk 3 times higher than their younger colleagues, showing the growth of progressive risk related to ageing.

In the sample of workers that we have examined, we founded

	OR	IC 95%	P-Value
Up to 45 years	0.29	0.17-0.49	0.0000
> 45	<b>3.38</b>	2.02-5.66	0.0000
Works inside tunnel	1.41	0.83-2.37	0.19
Works > 46 Hours/Week	<b>2.04</b>	1.24-3.37	0.004
Shift work	<b>2.78</b>	1.55-5	0.0004
Night shifts	<b>2.55</b>	1.45-4.48	0.0004
Weights > 5 Kg	<b>1.93</b>	1.07-3.51	0.02
Strain on equipment	<b>2.46</b>	1.40-4.32	0.001
Exposed to loud noise	<b>2.21</b>	1.18-4.13	0.001
Exposed to high temperatures	<b>1.93</b>	1.11-3.36	0.01
Exposed to weather conditions	1.28	0.67-2.45	0.44
Exposed to dusts and/or smoke	1.51	0.79-2.91	0.20
Exposed to a chemical compounds	<b>1.98</b>	1.15-3.42	0.01
Required to rush	<b>2.16</b>	1.24-3.74	0.005
Required to do different things than the assigned task	<b>1.98</b>	1.15-3.42	0.01
Required to take care of inferior or superior tasks than the assigned task	<b>1.98</b>	1.15-3.42	0.01
Interrupted during work	1.54	0.86-2.76	0.14
Work requires prolonged attention and concentration	<b>4.82</b>	1.73-13.43	0.001
Cannot avert the eyes from task	<b>2.50</b>	1.35-4.64	0.002
Required to maintain balance during dangerous situations	<b>1.99</b>	1.15-3.45	0.01
Often works Saturdays and Sundays	<b>2.32</b>	1.34-4.01	0.002
Has to sleep in irregular patterns due to job	<b>2.76</b>	1.60-4.76	0.0002
Has to eat in irregular patterns due to job	<b>2.62</b>	1.50-4.56	0.0005
Working task (Carpenter/Solderer)	1.11	0.67-1.83	0.67
Waist circumference > 93 cm	<b>2.84</b>	1.71-4.73	0.0000
BMI > 25	<b>2.88</b>	1.70-4.89	0.0006

**Table 7:** Bivariate analysis between arterial hypertension and some professional factors.

	OR	I.C.	P Value
Smoking	0.99	0.56-1.77	0.49
Sports	0.71	0.41-1.23	0.22
Drinking beer	0.72	0.43-1.22	0.23
Drinking wine	1.31	0.80-2.14	0.28
Gardening	1.15	0.70-1.90	0.57
Watching television	1.04	0.38-2.79	0.93

**Table 8:** Bivariate analysis between arterial hypertension and lifestyles.

	OR	IC 95%	P-Value
Works more than 46 hours/week	1.96	1.16-3.31	0.01
Shift work	2.47	1.34-4.54	0.003
Night shifts	2.24	1.25-4.01	0.006
Work requires prolonged attention and concentration	3.71	1.29-10.68	0.001
Cannot avert the eyes from task	2.00	1.05-3.81	0.003
Has to sleep in irregular patterns due to job	2.33	1.32-4.10	0.003
Has to eat in irregular patterns due to job	2.18	1.22-3.90	0.007

**Table 9:** Multivariate analysis: logistic regression between arterial hypertension and some professional determinants. Model controlled by age.

statistically significant associations, with many factors related to the professional activity and especially with those work determinants that can be attributed in particular to shift work, which doesn't allow regularity of meal or sleep times. In particular, alteration of sleep-wakefulness rhythms, during the night shift which is prolonged for a week and is repeated every three weeks, can cause the reduction of physiological sleep need which, based on the literature data [25] is associated to an increase of body mass and obesity.

Also cognitive factors, such as high concentration and attention seem to have an important role, since it seems they are able to increase two folds the hypertensive risk. This is even more evident when considering +45 years old subjects, in fact in the multivariate

analysis, in which associations were carried out considering also the different ages, we were able to observe how particularly for subjects over 45, taking care of a task that requires a prolonged attention and concentration represents a strong risk factor, with Odds Ratio of 3.75.

The excess of risk for the over 45 year olds requires corrective interventions of an organizational nature, like for example the alternation of heavier tasks and/or the increase of work breaks, to allow older workers to dilute the amount of work load and reduce the chances of arterial hypertension risk and more in general of risks for the cardiovascular system. After the age of 45, tolerance to physical strain diminishes, especially in worsened physical conditions and/or in absence of good training; in these conditions, maximum strain

even if short termed, can cause a growth of cardiovascular risk [26]. Other interventions should concern the programming of work shifts envisaging a more physiological articulation.

Besides remedial interventions to professional conditions, which, even if beneficial, are not always objectively and easily achievable, it would be advantageous also to plan and program actions directed towards the dietary education and to stimulate physical activity. These interventions would not only be useful to better the life conditions and reduce stress, but also to correct overweight condition, which are widespread among the workers and associated to the onset of arterial hypertension.

Furthermore sedentariness ought to be prevented, incentivizing physical activity during leisure time. Well known are the beneficial effects of physical activity, in particular regarding cardiovascular illnesses. Physical exercise, in fact, has been proved to reduce cardiovascular events and several other illnesses, for example, arterial hypertension, obesity, diabetes mellitus and depression [27].

Therefore, the benefits of these interventions would have positive repercussions on short and long term health conditions, with a decrease of work absences due to illness, on the improvement of working environment conditions, resulting in the overall improvement of these workers' quality life.

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