Meta-analysis: cardiovascular effects in workers occupationally exposed to urban pollution

There has not been any kind of language or typological restriction. Criteria of Eligibility: the research on cardiovascular effects includes control cases of workers exposed to urban pollution, compared with non-exposed subjects. Participants and Interventions: the selected studies present outdoor workers exposed to urban pollution (drivers and petrol pump attendants) and a control group of indoor workers (managers, university students and other selected subjects). Study Appraisal and Synthesis Methods: the evidences (independently token from two different authors) have been grouped in two classes, the first one formed by continuous variables (systolic blood pressure, diastolic blood pressure, heart rate, total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides) and the second one by discontinuous variables (electrocardiographic abnormalities prevalence, hypertension prevalence, hypercholesterolemia prevalence). The studies related to both classes and presenting more than one variable for each class have been included and used, in order to elaborate the results. We calculated heterogeneity in each variable (ES calculation for continuous variables and OR calculation for discontinuous variables). Results: on 378 publications, we have selected and included 16 articles. The variables show statistically irrelevant differences between exposed group and control group, except regarding the triglycerides. Limitations: The controlled studies are limited and characterized by a non-homogeneous evaluation of both expositional times of workers to urban pollution and of professional expositional values. Conclusions: considering the heterogeneity and the lack of studies, it is impossible at the moment to document effects on the cardiovascular system in workers exposed to urban pollution. The results of this meta-analysis only suggest the association of urban pollution with alteration of triglycerides blood levels (referring to just three studies). As reported in scientific literature on this subject, it is necessary to conduct a future professional investigation on this subject with more qualified and homogeneous studies.

KEY WORDS: cardiovascular system, cardiovascular diseases, urban pollution.

Introduction

Urban pollution is a considerable health problem all over the world (1).
Many observational and experimental studies in general population found an association between urban pollution and mortality due to cardiovascular diseases, considering urban pollution a possible joint cause of their onset (2-7).

Even if the process implying this connection is not yet fully explained, it is possible to recognize some risk factors, such as the exposition to chemical agents short-term (2, 8-11) and long-term (2, 5, 12-15) exposition to particulate matter, lead (16-21), cadmium (4), carbon monoxide (22) and to traffic noise (12, 13, 23, 24).

The aim of this meta-analysis is to conduct a systematic revision of the scientific evidence on cardiovascular effects in workers exposed to urban pollution (25). The intention is to determine possible cardiovascular effects and especially modifications of risk factors (as blood pressure, heart rate, lipid blood levels) of urban pollution on workers.

Methods

The study has been conducted and reported as in the MOOSE Consensus Statement (26). We did a systematic research of observational studies (control-cases from January 1988 to May 2010) reporting cardiovascular effects in exposed (cases) and non-exposed (control) subjects to urban pollution. We also considered known but not yet published data and acts of national and international conferences. A further examination of the bibliography in previously published articles, reviews and meta-analysis on this subject has been conducted, in order to find other useful publications. There has not been any kind of language or typological restriction to the research. The utilizable works have been identified with a systematic research on the following on-line search engines: Biomedcentral, MEDLINE/ PubMed, MEDLINE/ National Library of Medicine (NLM), MEDLINE Plus, Nioshctic-2, Scopus, TOXNET/Toxline. The research has been conducted introducing the following keywords, combined with “Boolean Operators”:

- police workers (or police officers or traffic police or traffic wardens) AND cardiac function, cardiovascular function, heart disease, cardiac diseases, cardiovascular diseases, cardiac system, cardiovascular system, blood pressure, heart rate, electrocardiogram, electrocardiography, hypertension;
- mail carriers (or postal workers) AND cardiac function, cardiovascular function, heart disease, cardiac diseases, cardiovascular diseases, cardiac system, cardiovascular system, blood pressure, heart rate, electrocardiogram, electrocardiography, hypertension;
- street vendors (or shop vendors) AND cardiac function, cardiovascular function, heart disease, cardiac diseases, cardiovascular diseases, cardiac system, cardiovascular system, blood pressure, heart rate, electrocardiogram, electrocardiography, hypertension;
- bus drivers AND cardiac function, cardiovascular function, heart disease, cardiac diseases, cardiovascular diseases, cardiac system, cardiovascular system, blood pressure, heart rate, electrocardiogram, electrocardiography, hypertension;
- taxi drivers AND cardiac function, cardiovascular function, heart disease, cardiac diseases, cardiovascular diseases, cardiac system, cardiovascular system, blood pressure, heart rate, electrocardiogram, electrocardiography, hypertension;
- filling station attendants (or petrol station attendants or gas station attendants or gasoline station attendants) AND cardiac function, cardiovascular function, heart disease, cardiac diseases, cardiovascular diseases, cardiac system, cardiovascular system, blood pressure, heart rate, electrocardiogram, electrocardiography, hypertension;
- road sweepers (or street sweepers or road cleaners or street cleaners) AND cardiac function, cardiovascular function, heart disease, cardiac diseases, cardiovascular diseases, cardiac system, cardiovascular system, blood pressure, heart rate, electrocardiogram, electrocardiography, hypertension;

Selection process and data abstraction

Two reviewers independently evaluated title, abstract and keywords in each resulting study and applied criteria of exclusion and inclusion. The same procedure was applied to full texts and used for the choice of the relevant data, in order to increase the reliability of the study. We included control-case studies dealing with both outdoor workers (cases – as local policemen and professional drivers) and indoor workers (controls – as administrative local agents, employees, university students and other selected subjects). Firemen and street maintenance staff were excluded, considering that their exposition to urban pollution is occasional and added to other harmful specific pollutions that can have effects on the cardiovascular system. We only considered the research in which the connection between urban pollution and cardiovascular effects had been studied according to at least one of the following variables: systolic blood pressure (SBP) and diastolic blood pressure (DBP) or hypertension prevalence, heart rate (HR), electrocardiographic abnormalities (ECGA).

We also considered blood lipids levels as total cholesterol (TCHO), LDL cholesterol (LDL) and HDL cholesterol (HDL), triglycerides (TRY) or prevalence hypertriglyceridemia or hypercholesterolemia, considering their importance in cardiovascular pathologies. All the articles not concerning our aim were excluded (articles not specifically dealing with the above-mentioned tasks, not based on the control-case system and with incomplete or lacking data).

Data analysis

The Effects Size (ES), reflecting the strength of the relationship between two variables, was performed by Standardized Mean Difference (SMD) or Weighted Mean Difference (WMD), at the presence of heterogeneity, when the data were expressed in the media and Standard Deviation, for continuous variables.
(Class I). While it was expressed by Odds Ratio (OR) when the data were expressed as frequency, for the discontinuous variables (Class II). For measures of ES based on the Odd Ratio (OR), a ratio of 1.0 indicates the lack of differences among the studied groups. The heterogeneity among the used data, referring to the variability or differences among studies in estimating the effect, was assessed with the Index of Inconsistency ($I^2$). Using $I^2$ we calculated the percentage of variance due to heterogeneity rather than the real case. If the value of $I^2$ was close to zero the observed variance was due to chance, if it was higher the variance was due to several factors that need to be investigated. The calculation of ES was made using the Random Effects Model (REM) for high values of $I^2$ and the Fixed Effects Model (FEM) for $I^2$ values close to zero (27).

Results

With the application of this criteria, we chose 378 publications. All the articles not inherent with our research were excluded. We examined the full texts of 80 potentially acceptable articles and 16 of them (Tab. 1) respected the criteria for inclusion. All the subjects (7714 workers) were divided into two groups, the exposed (EX = 3699 outdoor workers) and the control group (C = 4015 indoor workers). We grouped the studies according to the nature of each investigated variable and identified two classes of variables: continuous variables (systolic blood pressure, diastolic blood pressure, heart rate, total cholesterol, HDL cholesterol, LDL cholesterol, triglycerides) and discontinuous variables (electrocardiographic abnormalities prevalence, hypertension prevalence, hypercholesterolemia prevalence).

Even if at first we identified a prevalence of hypertriglyceridemia, we did not conduct statistical analysis on it, because it was treated in one work only. The studies that reported data for both classes and several variables for each class were entered and processed more than once for the elaboration of results. Evaluating the parameters for Class I, we included a total of 3774 workers divided into two groups: 2037 subjects in the exposed group (EX) and 1737 subjects in the control group (C). In the assessment of parameters related to discontinuous variables we included a total of 11737 workers: 6978 EX and 4759 C. Tables 2 and 3 summarise the results of studies.

Results of Continuous variables: Class I

Systolic and diastolic blood pressure, evaluated in eight studies (12, 13, 28-33), and heart rate, in two studies (31, 34), show no statistically significant differences in the exposed compared to controls. The studies were heterogeneous between them. For the lipid parameters, total cholesterol, measured in four studies (12, 14, 28, 31), and LDL cholesterol, measured in one study (12) show no statistically significant differences and are characterized by a low index of heterogeneity. HDL cholesterol, measured in three studies, (12, 14, 31) shows no statistically significant differences, but is characterized by a high level of heterogeneity. Regarding triglycerides, measured in three studies (12, 14, 28), there is a statistically significant difference in the exposed compared to controls, with a low index of heterogeneity.

Results of Not-continuous variables: Class II

Prevalence of electrocardiographic abnormalities, evaluated in five studies (12, 35-38) took twice and the prevalence of hypertension assessed in two studies (36, 37), do not give statistically significant differences in the exposed compared to controls, with a high degree of heterogeneity.

Regarding the data on the prevalence of hypercholesterolemia, evaluated in two studies (35, 36), there are not statistically significant differences in the exposed compared to controls, with a high degree of heterogeneity.

Conclusions

Many studies in the general population show the association between exposure to urban pollution and cardiovascular effects, such as hypertension (39), ischemic heart disease, arrhythmias, heart failure, stroke and sudden death (3), probably for alterations of the cardiac autonomic and myocardial perfusion and electrical instability (3, 5, 40, 41). In addition, airborne particulates, according to the theory of Twickler et al. (42), conveyed by the lipids, would be able to infiltrate the vessel intima by promoting the formation of atherosclerotic plaques. Hence the importance of early assessment in subjects exposed to any load changes in heart rate, blood pressure, lipid blood levels and electrocardiogram.

The meta-analysis shows that the association between occupational exposure to urban air pollution and cardiovascular effects gives statistically significant values in outdoor workers only for the blood levels of triglycerides. This value is however relative, as reported in only three studies (12, 14, 28).

The result is confirmed by the work of Wang, that was not included in the meta-analysis because it is a single work. The study, conducted on a large number of subjects, reports a statistically significant difference in the prevalence of hypertriglyceridemia between bus drivers and skilled workers.

We found the same limitation of controlled studies also in the evaluation of other examined variables. Reviewed studies are heterogeneous, as to the outcomes. Among 16 studies of our meta-analysis, only five focused on the association between urban pollution and effects on the cardiovascular system (12, 13, 29, 32, 47). One of the remaining studies (37) (analyzing the incidence of coronary heart disease in professional drivers), identified among the potential risk factors both urban pollution and specific work factors. Four studies as-
<table>
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<tr>
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<th>Country</th>
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<tbody>
<tr>
<td>Biava</td>
<td>Italy</td>
<td>292 traffic policemen/60 hospital used employees as control group</td>
<td>Cross-sectional study</td>
<td>The effects caused by exposition to urban pollutants (chemical matters, IPA, benzene, asbestos, lead, monoxide)</td>
<td>Objective examination Spirometry Electrocardiogram Neurological visit Determination of motor conduction's velocity of median nerve Psychological questionnaire Blood lead levels Blood carboxyhemoglobin levels Chemistry exam (blood test)</td>
<td>There is a statistically significant difference between exposed group and control group about musculo-skeletal disorders and about blood lead level</td>
<td>Cardiac disorders EX Male 2/179 (1.2), EX Female 0/113 (-) C Male: 1/36 (2.7), C Female 1/24 (4.1)</td>
</tr>
<tr>
<td>Bigert</td>
<td>Swedish</td>
<td>106 professional drivers/1482 control group selected from general population</td>
<td>Observational study</td>
<td>Heart attack risk in professional drivers (bus, taxi and truck drivers)</td>
<td>Valuation of heart attack risk factors: smoke cigarette's habit alcohol's consumption physical exercise during spare time overweight diabetes mellitus hypertension social-economical status work commitments</td>
<td>Results of this study show that Odds Ratio for heart attack in bus drivers is 2.14 (IC 95% 1.34-3.41), in taxi drivers heart attack is 1.88 (IC 95% 1.19-2.98) and in truck drivers heart attack is 1.66 (IC 95% 1.22-2.26)</td>
<td>Prevalence hypertension EX 30/106 C 23/1482</td>
</tr>
<tr>
<td>Cervone</td>
<td>Italy</td>
<td>28 men traffic policemen/14 control group selected from general population</td>
<td>Observational study</td>
<td>Effects of exposure to urban pollution on health and the activation of immune system in traffic policemen</td>
<td>Anamnestic questionnaire Blood pressure Chemistry exams (blood test) Urinary lead levels Lymphocyte subpopulations' study</td>
<td>Urinary lead values are significantly increased in exposed group compared to control group (p&lt;0.01).</td>
<td>EX: SBP 123.8 (13.6), DBP 82.4 (6.6), CHOL TOT 238 (46), TRY 185 (124), GLY 97 (15) C: SBP 127.2 (16.1), DBP 78.6 (9.3), CHOL TOT 229 (55), TRY 137 (85), GLY 97 (27)</td>
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Table 1 (cont.) - Characteristics of included studies.

| Study      | Country | Participants                                                                 | Study design         | Outcomes                                                                 | Method                                                                 | Main results                                                                 | Evaluated Variables                                                                 |
|------------|---------|------------------------------------------------------------------------------|----------------------|---------------------------------------------------------------------------|-------------------------------------------------------------------------|-------------------------------------------------------------------------------|
| Hedberg    | Swedish | 440 men professional drivers/1000 men subjects control group                 | Observational study  | Risk factors of cardiovascular disease in professional drivers            | Anamnestic questionnaire, Objective examination, Blood pressure, Chemistry exams (blood test) | Results of this study show that Odds Ratio (OR) for cardiovascular risk in professional drivers is 3.18 (IC 95% 2.41-4.20) compared to control group. | EX: CHOL TOT 6.32 (6.19-6.45), HDL 1.26 (1.23-1.30), TRY 1.85 (1.51-2.19), Prevalence hypertension 33/440. C: CHOL TOT 6.30 (6.22-6.39), HDL 1.28 (1.25-1.30), TRY 1.63 (1.55-1.71), Prevalence hypertension 35/1000. |
| Mormontoy  | Perú    | 52 traffic policemen/50 police officers employed in indoor activity          | Cross-sectional study | Blood lead levels and the effects of exposure to vehicular traffic on cardiovascular system | Anamnestic questionnaire, Blood pressure, Chemistry exams (blood test) Blood lead levels | Blood lead levels are statistically increased in exposed group compared to control group. | EX: SBP 113.02 (9.29), DBP 73.94 (7.75) C: SBP 114.18 (8.20) DBP 75.20 (8.35) |
| Pala       | Turkey  | 78 traffic policemen/21 police officers employed in indoor activity          | Observational study  | Blood lead levels and the effects of exposure to vehicular traffic on cardiovascular system | Anamnestic questionnaire, Blood pressure, Chemistry exams (blood test) Blood lead levels | Results of this study show that there is not a statistically significant difference between exposed group and control group about blood pressure and blood lead levels. | EX: SBP 119.5 (16.3), DBP 75.9 (10.2) C: SBP 116.4 (13.2) DBP 76.20 (10.50) |
| Sakata     | Nepal   | 27 men taxi drivers/9 men university students and farmhands                 | Observational study  | The dose-response relationship between blood lead levels and erythropoietin serum concentration in taxi drivers exposed to lead of vehicular emission | Blood pressure, Chemistry exams (blood test) Heart rate Erythropoietin serum levels Urine analysis | Erythropoietin serum levels are significantly reduced in exposed group compared to control group Blood lead levels are increased in exposed group compared to control group. | EX: SBP 135 (12), DBP 79.0 (10), HR 78 (10), CHOL TOT 149 (28), CHOL HDL 37.9 (7.8) C: SBP 122 (8), DBP 78 (9), HR 71.4, CHOL TOT 157 (26), CHOL HDL 37.6 (9.3) |

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Table 1 (cont.) - Characteristics of included studies.

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<tr>
<td>Sancini</td>
<td>Italy</td>
<td>115 traffic police smokers/115 police officers employed in indoor activity smokers 280 traffic police non smokers/280 police officers employed in indoor activity non smokers</td>
<td>Observational study</td>
<td>Blood pressure changes and electrocardiographic abnormalities in traffic policemen exposed to urban pollution</td>
<td>Anamnestic questionnaire Objective examination Blood pressure Electrocardiogram</td>
<td>Blood systolic pressure average value at rest and electrocardiographic abnormalities' frequency is statistically increased in non smoker male subjects of exposed group compared to men non smoker control group Blood systolic pressure average value at rest is statistically increased in non smoker male subjects of exposed group compared to men smokers of exposed group Electrocardiographic abnormalities' frequency is statistically increased in non smoker male subjects of control group compared to men smoker control group</td>
<td>SMOKERS: EX. Male: SBP 126 (13.2), DBP 78.5 (9.1), ECG abnormalities 8 (19.0) C Male: SBP 129 (14.2), DBP 81.4 (10.5), ECG abnormalities 13 EX. Female (30.9) SBP 114.4 (13.6), DBP 72.6 (9.8), ECG abnormalities 4 (5.4) C Female SBP 114.6 (14.2), DBP 73.2 (9.8), ECG abnormalities 7 (9.5) NON SMOKERS: EX Male: SBP 134.7 (19.2), DBP 82.2 (8.9), ECG Abnormalities 30 (20.8) C Male: SBP 128.6 13.6(1), DBP 81.3 (8.4), ECG Abnormalities 15 (10.4) EX Female: SBP 116.2 13.8), DBP 72.9 (9.5), ECG Abnormalities 16 (11.7) C Female: SBP 116.6 (12.5) DBP 75.9 (14.7), ECG Abnormalities 15 (11)</td>
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<tr>
<td>Sardelli 1995 (35)</td>
<td>Italy</td>
<td>120 traffic policemen/30 administrative workers</td>
<td>Observational study</td>
<td>Health effects of exposure to urban pollution and noise in traffic policemen</td>
<td>Anamnestic questionnaire Objective examination Blood pressure Cardiology visit Electrocardiogram Otorhinolaryngology visit Chest radiography Audiometry Chemistry exams (blood test) Pneumotacograph</td>
<td>Blood cholesterol levels are significantly increased in exposed group compared to control group. Spirometry shows that respiratory obstructive diseases are increased in exposed group compared to control group and that mild hypertension is increased in exposed group more than control in group</td>
<td>EX: prevalence hypercholesterolemia 80/120 Prevalence Hypertension moderate: N. 14 ECG Abnormalities prevalence: N. 28 C: prevalence hypercholesterolemia 8/30 Prevalence Hypertension moderate: N. 2 ECG Abnormalities prevalence: N. 8</td>
</tr>
<tr>
<td>Tomao 2002 (14)</td>
<td>Italy</td>
<td>118 men traffic policemen 118 police officers employed in indoor activity</td>
<td>Observational study</td>
<td>Lipid metabolism in traffic policemen exposed to urban pollution</td>
<td>Anamnestic questionnaire Objective examination Chemistry exams (blood test)</td>
<td>HDL average values are significantly reduced in exposed group compared to control group, instead triglycerides average values are significantly increased in exposed group compared to control group</td>
<td>EX: CHOL TOT 208.2 (46.4), HDL 29.9 (7.2), TRY 173.8 (168.9) C: CHOL TOT 202.6 (36.8), HDL 55.3 (9.9), TRY 138.1 (88.7)</td>
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<tr>
<td>Tomei</td>
<td>Italy</td>
<td>77 non smokers, traffic policemen/87 non smokers, police officers employed in indoor activity</td>
<td>Observational study</td>
<td>Blood pressure changes in traffic policemen exposed to urban pollution through ambulatory monitoring of blood pressure during 24 hours</td>
<td>Anamnestic questionnaire, Objective examination, Chemistry exams (blood test), Blood pressure monitoring of blood pressure during 24 hours</td>
<td>Blood systolic pressure average value monitored during 24 hours is statistically increased in non smoker male subjects of exposed group compared to men non smoker control group. Blood diastolic pressure average values monitored during 24 hours, between 6 am and 11 am and between 10 pm and 6 am, are statistically increased in non smoker male subjects of exposed group compared to non smoker male subjects in control group</td>
<td>EX: SBP 135 (12), DBP 79.0 (10), CHOL TOT m 225.8 (55.2), CHOL TOT f 188.6 (40.7), CHOL HDL m 43.4 (5.8), CHOL HDL f 58.7 (13.2), TRY m 181 (198.2), TRY f 107 (48), LDL m 146 (34.4), LDL f 108.3 (31.4). C: SBP 122 (8), DBP 78 (9), CHOL TOT m 230.4 (26.9), CHOL TOT f 191.1 (26.8), CHOL HDL m 43.1 (3.65), CHOL HDL f 48.7 (8.9), TRY m 167.8 (56), TRY f 95.9 (31.5), LDL m 153.7 (26.85), LDL f 125.3 (30.9).</td>
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<tr>
<td>Volpino</td>
<td>Italy</td>
<td>68 men traffic policemen/62 police officers employed in indoor activity</td>
<td>Observational study</td>
<td>The effects of exposure to urban pollution on cardiovascular and respiratory systems in traffic policemen</td>
<td>Anamnestic questionnaire, Objective examination, Chemistry exams (blood test), Blood pressure, Heart rate, Respiratory frequency, Electrocardiogram, Stress electrocardiogram, Hemogasanalysis, Spirometry</td>
<td>Diastolic pressure average values during rest period are statistically increased in exposed group compared to control group. Diastolic pressure average values during stress are statistically increased in exposed group compared to control group</td>
<td>EX: Prevalence Hypertension 16/68, SBP 130 (12.6), DBP 85.7 (8.5), C: Prevalence Hypertension 16/62, SBP 127 (8.4), DBP 81.9 (6.8).</td>
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<tr>
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<td>Outcomes</td>
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<tr>
<td>Wang</td>
<td>Taiwan</td>
<td>1761 male bus drivers/536 male administrative workers</td>
<td>Observational study</td>
<td>Cardiovascular risk factors in bus drivers exposed to vehicular emissions and urban pollution</td>
<td>Anamnestique questionnaire, Objective examination, Chemistry exams (blood test), Electrocardiogram</td>
<td>Hypertension, hypercholesterolemia, hypertriglyceridemia and electrocardiograph abnormalities are statistically increased in exposed group compared to control group</td>
<td>EX: Prevalence Hypertension 986/1761, Prevalence hypercholesterolemia 598/1761, Prevalence hypertriglyceridemia 376/1761</td>
</tr>
<tr>
<td>Zefferino</td>
<td>Italy</td>
<td>30 traffic policemen, studied during a working day/30 traffic policemen studied during a day off.</td>
<td>Observational study</td>
<td>The effects of exposure to urban pollution on heart rate in policemen employed in emergency care</td>
<td>Anamnestique questionnaire, Objective examination, PSS test (Professional Stress Scale Test), Cortisol salivary levels, Salivary IL-1B levels, Electrocardiogram, Study of heart rate variability</td>
<td>Cortisol levels are significantly higher at the beginning of work shift than at the end. In the morning during holiday, average cortisol concentration is statistically decreased compared to cortisol concentration in the afternoon. T test shows statistically significant difference between average cortisol levels at the same time during holidays and working days. IL-1-B average concentration at the beginning of work shift is higher than at the end of work shift (p&lt;0.05). Statistical analysis shows statistically significant association between LF/HF (low frequency/high frequency) of heart rate measured at 8 am of day off and the difference of salivary cortisol levels at work</td>
<td>EX HR during work 78.53 (10.47) C: HR during holiday 74.46 (8.84)</td>
</tr>
</tbody>
</table>
Zefferino
Italy 30 traffic policemen
studied during a
working day/30 traffic
policemen studied
during a day off
Observational study
Some salivary stress markers in policemen employed in emergency care
Anamnestique questionnaire
Objective examination
PSS test (Professional Stress Scale Test)
Cortisol salivary levels
Salivary IL-1B levels
Electrocardiogram
Blood pressure
Cortisol levels are significantly higher at the beginning of work shift than at the end (p<0.05).
During holiday in the morning, average cortisol concentration is statistically decreased compared to cortisol concentration in the afternoon (p<0.05).
T test shows statistically significant difference between cortisol average levels at the same hour during holiday and working days (p<0.05).
IL1-B average concentration at the beginning of work shift is higher than at the end (p<0.05).

Zhang
China 36 traffic policemen
and 277 gasoline
workers/342
administrative workers
Observational study
The aim of this study is to evaluate the effects of lead exposure on workers' health
Anamnestique questionnaire
Objective examination
Electrocardiogram
Urinary lead levels
Urinary diethyl lead levels
Triethyl lead levels
Results show no statistically differences between exposed group and control group about electrocardiographic abnormalities
EX (Traffic policemen and 277 gasoline workers): ECG Abnormalities prevalence 18.5/277, 8.33/36
C: ECG Abnormalities prevalence 6.43/342
assessed the effects of urban pollution on health, including the cardiovascular system (28, 35, 36, 38). One study (14) investigated the effects of urban pollution on the lipidic asset; this alteration is a known cardiovascular risk factor. In their work, Pala and Sakata (30, 31), evaluated blood lead levels respectively in policemen and taxi drivers; the first incorporated blood pressure within the parameters of the assessment. The second incorporated heart rate and the lipidic asset.

In conclusion, three more studies (34, 44), dealing with subjects professionally exposed to urban pollution, attributed the cardiovascular effects in outdoor workers to stress.

Even in literature it comes out stress is higher in workers exposed to urban pollution (45-48).

A non-uniform assessment of both time of exposure to pollution of urban workers, sometimes not even mentioned, and of values of occupational exposure (environmental monitoring and/or organic) is a further problem. With the exception of Sardelli and Zhang who quoted environmental measures [Sardelli P et al., 1995; Zhang W et al., 1994] and Volpino, Tomei and Sancini who evaluated biological indicators (Sancini A et al., 2010; Tomei F at al., 2004, Volpino P et al., 2004), other authors recruited subjects only considering their work task, simply monitoring the exposure on the base of questionnaires or assuming Mormontoy (Mormontoy W et al., 2006) that traffic police officers are exposed to pollution from vehicular traffic. Therefore, considering data from the scientific literature, related to the general population, which impute

Table 2 - The results of Class I (continuous variables).

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>NUMBER OF SUBJECTS</th>
<th>P</th>
<th>I² %</th>
<th>Meta-analysis index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic blood pressure</td>
<td>EX: 518 C: 417</td>
<td>P 0.239</td>
<td>37.4</td>
<td>SMD 0.093 [-0.062; 0.247]</td>
</tr>
<tr>
<td>Diastolic blood pressure</td>
<td>EX: 518 C: 417</td>
<td>P 0.126</td>
<td>47.8</td>
<td>SMD 0.121 [-0.34; 0.275]</td>
</tr>
<tr>
<td>Heart rate</td>
<td>EX: 57 C: 39</td>
<td>P 0.126</td>
<td>47.8</td>
<td>WMD 0.121 [-0.34; 0.275]</td>
</tr>
<tr>
<td>Total cholesterol</td>
<td>EX: 293 C: 257</td>
<td>P 0.358</td>
<td>0.00</td>
<td>WMD 0.094 [-0.106; 0.295]</td>
</tr>
<tr>
<td>HDL cholesterol</td>
<td>EX: 265 C: 243</td>
<td>P 0.43</td>
<td>98.4</td>
<td>SMD 0.897 [-3.171; 1.37]</td>
</tr>
<tr>
<td>LDL cholesterol</td>
<td>EX: 120 C: 116</td>
<td>P 0.87</td>
<td>0.00</td>
<td>WMD 0.054 [-0.485; 0.378]</td>
</tr>
<tr>
<td>Trygliceridaes</td>
<td>EX: 266 C: 248</td>
<td>P 0.009</td>
<td>0.00</td>
<td>WMD 0.280 [0.070; 0.489]</td>
</tr>
</tbody>
</table>

EX = Experimental Group  
C = Control Group  
P = Probability  
I² = Heterogeneity Index  
SMD = Standardized Mean Difference  
WMD = Weighted Mean Difference

Table 3 - The results of Class II (not-continuous variables).

<table>
<thead>
<tr>
<th>VARIABLE</th>
<th>NUMBER OF SUBJECTS</th>
<th>P</th>
<th>I² %</th>
<th>Meta-analysis index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrocardiographic alterations</td>
<td>EX: 2602 C: 1083</td>
<td>P 0.702</td>
<td>73.0</td>
<td>OR = 1.165 [0.53; 2.55]</td>
</tr>
<tr>
<td>Hypertension</td>
<td>EX: 2495 C: 3110</td>
<td>P 0.169</td>
<td>86.3</td>
<td>OR = 1.39 [0.86; 2.33]</td>
</tr>
<tr>
<td>Hypercholesterolemia</td>
<td>EX: 1881 C: 586</td>
<td>P 0.37</td>
<td>87.6</td>
<td>OR = 1.73 [0.51; 5.86]</td>
</tr>
</tbody>
</table>

EX = Experimental Group  
C = Control Group  
n.s. = not significant  
P = Probability  
I² = Heterogeneity Index  
ES = Effect Size  
OR = Odd ratio

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adverse cardiovascular effects to urban pollution and given the data emerging from our meta-analysis on population occupationally exposed, we believe it’s very important to carry on research occupationally exposed groups. To increase the reliability of the parameters relating to the effects of urban pollution on the cardiovascular system, studies should pay particular attention to procedures ascertaining level and type of pollutants, duration and terms of exposure, age of the subjects evaluated, type of job and presence of other environmental stressors, as well as personal ones, that can affect cardiovascular function, such as smoking, incorrect eating habits and excess fat mass.

References