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Cardiovascular risk factors of Central European employees deployed to low-income countries

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Abstract

Objective: To evaluate whether employees of an ageing society have an increased risk for cardiovascular events compared to the general population. This is of special interest when they are deployed to low-income countries with limited medical infrastructure.

Material methods: A total of 189 employees was included in the cross-sectional cohort study. Countries of deployment were SE Asia, South America, and Sub-Saharan Africa. The following data were evaluated: age, body mass index, smoking habits, HbA1c, total cholesterol, LDL, HDL, triglycerides, ESC score, HDL/LDL-index, TCL/HDL ratio, PROCAM score, Framingham score.

Results: The mean age was 46.4 years, the Body Mass Index (BMI) was 27.8. 84.5% showed increased systolic blood pressure, 5.6% suffered from diabetes and in another 14.8% prediabetes must be assumed. Mean total cholesterol (TCL) level was 212.4 mg/dl. ESC risk score indicated a low risk in 6.6%, in 75.5% it was moderate, in 9.4% high, and in 8.5% very high. Framingham score: 55.4% low risk, 28.0% moderate, and 16.6% high risk. Atherogenic index: 70.3% increased risk, and 6.1% high risk. All factors investigated are significantly higher than in the general European population of the same age distribution.

Conclusion: Compared with the general population of similar age the employees show a higher risk concerning all factors investigated. This must be addressed in any strategy to provide health and safety when employees of an ageing society should be deployed in low-income countries.

Keywords: work abroad, myocardial infarction, hypertension, cholesterol, glycated haemoglobin, CVD risk score, travel risk assessment, deployment

Introduction

While most data concerning increased cardiocirculatory risk in deployed employees focus on military personnel [1], such risk is scarce for civilian employees deployed to middle or low-income countries. Existing research has identified a significantly higher alcohol consumption level [2] among overseas workers, along with an increased health risk due to lifestyle and risk behaviour in general [3]. For example, Zaman et al. (2015) reported that most Saudi Arabian expatriates were either overweight or obese and did little or no exercise [4]. Data from Sulaiman et al. (2016) was marginally better (32.3% obese expatriates, n=2724) [5]. Consequently, an increased risk should be assumed. Other studies also support this assumption. For instance, Achmed et al. (2017) found 49.8% of subjects had more than three cardiovascular risk factors [6]. However, the prevalence of CVD risk factors was higher in the local population compared to the studied expatriates. Elkum et al. (2014) had a similar finding. The prevalence of CVD risk factors in South Asian expatriates in Kuwait exceeded those reported in their native homeland and other countries which suggested other stresses and acculturation factors may also be contributory risk factors.

In expatriates sent on regular assignments for the United Nations, severe cardiovascular incidences or even death are among the most essential diagnoses for medical evacuation [7]. In that study, 199 cases were reviewed for the causes of the medical evacuations (n=162) or deaths (n=37). CVD accounted for 11% of evacuations, and there was one sudden cardiac death by myocardial infarction. These cases occurred in SE Asia in regions with a low medical infrastructure (Bangladesh).

Most existing studies discussing the cardiocirculatory risk of employees working in foreign countries have examined workers in the Middle East and Arab states. Any research concerning Europeans or Americans (except military veterans) is even more scarce. The Society for German Expatriates [8] reported that more than 1.9 million Germans work abroad. According to this data, most lived in America (1.1 million), Switzerland and the U.K each had 270,000, and 200,000 lived in France, Italy, or Spain [9,10]. Detailed data about other countries were unavailable, especially from Africa or SE Asia. In 2022, around 7.1 million EU citizens aged 15 and over were working in another EU country without being a citizen of that country [11]. In the same year, 685,000 Swiss citizens worked abroad. It has been estimated that 16% of them go to India [12]. The “typical” European expatriate is male (52%), about 46 years old, has a university degree (82%), is allied at home (55%) but travels alone abroad (80%) [13].

This study investigated their cardiovascular risk factors with a relatively homogeneous collective of expatriates from German-speaking European countries (Germany, Switzerland, and Austria) who were regularly deployed to SE Asia (India, Pakistan, Bangladesh, Indonesia, and China). In the context of this study, the term ‘deployed’ is intended to highlight the fact that, because of their employment contract, individuals have very limited influence over where their employer sends them.

Material and methods

All persons who the authors examined as part of their occupational health care were included in the cross-sectional study (n=189 Caucasian persons: 176 (93.1%) males, 13 (6.9%) females). Almost all of them were fitters and service staff in the mechanical engineering sector; only a few were from the sales department. The examination followed the German recommendation “G35” (“Work placements abroad involving particular climatic or health-related challenges“). This involves a preventive medical examination, including comprehensive advice on maintaining good health whilst abroad, tailored to the specific risks involved (e.g. drinking water hygiene, food hygiene, vaccinations, malaria prevention, crime/violence and others). The employer must offer this examination to every employee travelling to the relevant countries. For decades, almost all those concerned have taken up this offer. Consequently, the target group is reached almost in its entirety.

During the examination a detailed clinical history was taken concerning cardio-metabolic problems and lifestyle factors. Demographic data was collected on: sex, age, height, weight, BMI, blood pressure (Riva-Rocci method), glycated haemoglobin, lipoproteins, and smoking history. The pack years of cigarette smokers was calculated using the calculator of the Royal College of General Physicians (www.smokingpackyears.com). Glycated haemoglobin (HbA1c) was analysed from venous whole blood samples by ion exchange-high-performance liquid chromatography. The results were interpreted according to the new DDG (German Society for Diabetes) recommendations [14]. Total cholesterol (TCL), low-density lipoproteins (LDL), and high-density lipoproteins (HDL) were analysed as usual in the hospital's routine laboratory. From these results, the following risk factors were calculated: HDL/LDL ratio (atherogenic index), TCL/HDL ratio, ESC risk score, and the Framingham score [15,16,17,18]. For datasets that included triglycerides, the PROCAM score was also calculated [19]. Table 1 gives the classification details for these individual risk factors.

The parameters evaluated were compared with the corresponding data of the adult German population published by the Office for Federal Statistics (https://www.destatis.de/EN/Themes/Society-Environment/Health/_node.html). Statistics were performed with non-parametric tests (Chi-square test, Mann-Whitney U test) with P<0.05 defined as significant. As the aim of the study was to determine, on the basis of established risk factors, whether this group was at increased risk of cardiovascular disease compared with the general population – and not to identify which risk factor was particularly relevant to the overall risk – these factors were examined in comparison with the general population, and a multivariate analysis was not carried out.

The study was performed according to the declaration of Helsinki [20] after review by the Ethics Committee at RWTH Aachen Technical University, Germany (Ref.No. EK 24-052).

Results

Collective and risk factors

A total of 189 employees (176 males (93.1%) and 13 females (6.9%)) were included in the study. The mean age was 46.4 years (SD 12.7; range 24-68 y), with 48.6% aged 50+ (Figure 1a). Mean body height was 181.9 cm (SD 9.8; range 160-200 cm), mean weight was 92.1 kg (SD 16.6; range 59-145 kg), and mean Body Mass Index (BMI) was 27.8 (SD 3.9; range 20.5-38.9). BMI results are given in Table 2 and compared with the overall percentage prevalence of the German adult population by sex from 2013. Over half of the participants were overweight compared to 44% of the German adult population, and 23.3% were obese. Smoking history was available from 175 participants: 105 (60.0%) were non-smokers, 32 (18.3%) were smokers, and 38 (21.7%) were ex-smokers. The mean pack years of the smokers and ex-smokers was 20.6 (SD 28.3; range 1-160).

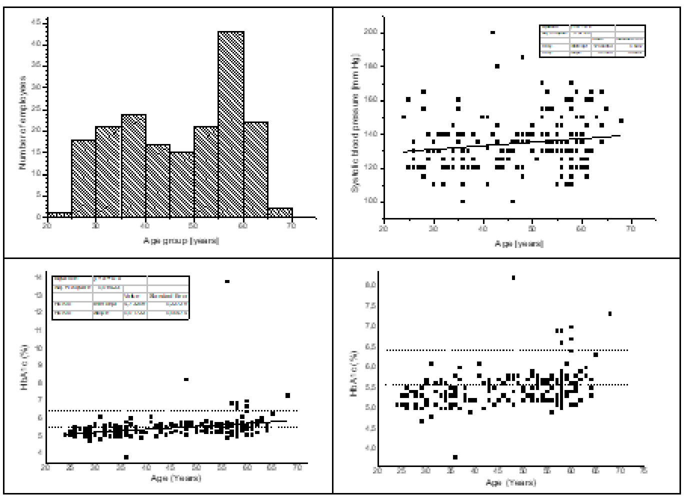

Figure 1a-d: Basic data of the collective. 1a (above left): Age distribution of the collective (n=185). Note: Compared to typical industrial collectives from Central Europe, there is a significantly higher number of employees aged 50+. 1b (above right): Systolic blood pressure of the collective. 1c (bottom left): HbA1c concentrations and the range of prediabetes and diabetes according to the DDG recommendations [14] are indicated by dash lines. 1d (bottom right): Data from (Figure 1c)whereby the extreme values were excluded in order to better resolve the collective distribution: A significant proportion of the subjects have prediabetes according to the thresholds given by DDG [14]

Most employees were regularly deployed for weeks or months to Pakistan, Bangladesh, India, China, and Indonesia, and a few went to Brazil, Mexico, and Burkina Faso. The mean systolic blood pressure was 134.6 mm Hg (SD 15.1; range 100-200 mm Hg). Only 43 persons (24.7%) had systolic blood pressure within the normal range, while 131 (75.3%) measured 140 mm Hg or more, of which 16 of them (9.2%) were higher than 160 mm Hg (Figure 1a). From the 91 (51.4%) non-smokers, 37 (20.9%) had stopped smoking more or less long ago; while 28 (27.7%) were active smokers. Most smokers or ex-smokers reported about 25 pack years, but some (including young persons) reported an excessive number of pack years (mean 20.6; SD 28.3; range 1-160; n=70).

HbA1c was available from 162 employees. The mean HbA1c was 5.5% (SD 0.5; range 3.8-13.8), and this increased significantly with age (Figure 1c-d). Most participants (129/162; 79.6%) were non-diabetic, but 9 (5.6%) had manifest diabetes (with one case entirely out of control whose HbA1c was 13.8%), and in another 24 (14.8%) prediabetes must be assumed (HbA1c between 5.7 and 6.4%). Of significance in the latter two groups, 5/8 and 21/24, respectively, had no idea about their (pre-) diabetes before the check by occupational medicine.

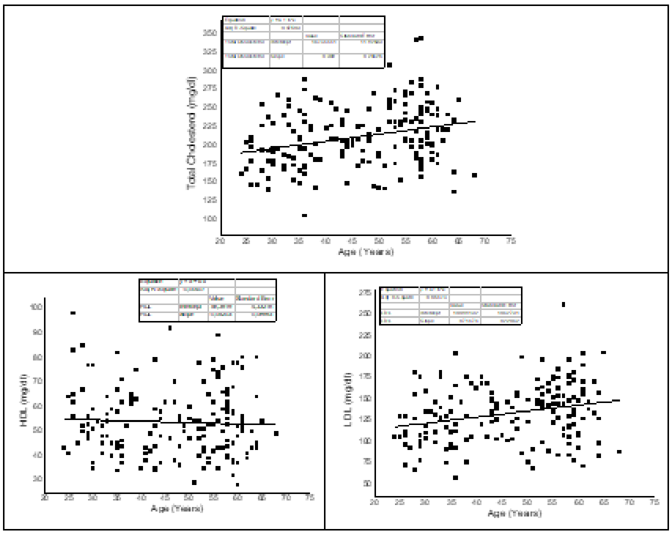

Figure 2a-c: Total cholesterol (above), HDL (bottom left) and LDL cholesterol (bottom right) of the collective

Cholesterol data was available from 171 participants. The mean total cholesterol (TCL) level was 212.4 mg/dl (SD 37.7; range 105-343). In 104/171 (60.8%) subjects, the TCL levels were above 200 mg/dl (Figure 2a). TCL increased significantly with age. While 36/62 subjects aged up to 40 years were below the recommended limit (58.1%), 61/86 (70.9%) of those aged 50+ showed increased levels ($p<0.001$). The mean HDL level was 54.0 mg/dl (SD 12.4; range 28-98, (Figure 2b)), and the mean LDL level was 134.2 mg/dl (SD 32.7; range 57-261, (Figure 2c)). Three persons showed very low LDL concentrations (<70 mg/dl), 27 had low levels (70-100 mg/dl), 47 were within the normal range (100-130 mg/ml), and 88 showed concentrations higher than 130 mg/dl. Most (n=137) participants had HDL levels above 40 mg/dl, and 28 had less. With age, LDL also increased significantly ($p<0.001$, Fig.2c). In contrast, HDL decreased ($p<0.05$) (Figure 2b). Triglycerides (TRI) were available for some participants only (n=13). However, this data indicated persons with very high TRI levels.

Risk Scores

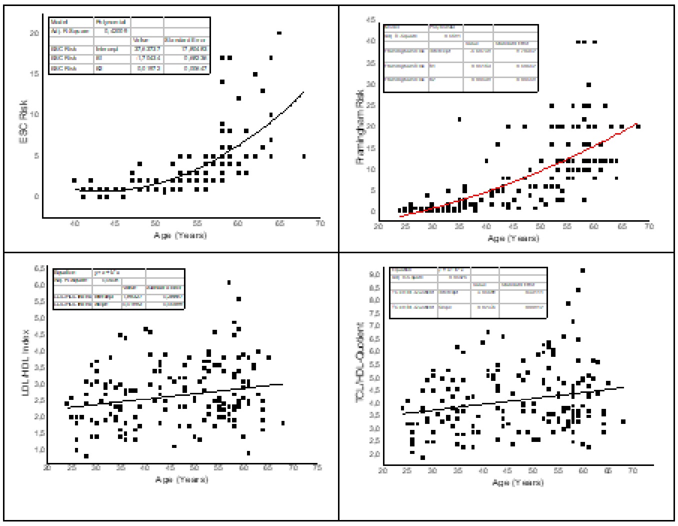

Figure 3a-d: Risk scores of the collective. 3a (above left): ESC risk score. 3b (above right): Framingham Score. 3c (bottom left): Atherogenic index. 3d (bottom right) TCL/HDL ratio.

Table1: Threshold Values and Risk Classification of Cardiovascular Risk Parameters

Data or score	**Thresholds / average values and risk classification**
ESC score	Risk classification: <1% „low"; 2-5% „moderate"; 6-9% „high"; >9% „very high"
Framingham score	Risk classification: <9% „low"; 10-16% „moderate"; >16 „high"
PROCAM score	Risk classification: <=2% „low"; 3-5% „increased"; 6-20% „significantly increased"; >20% „high-risk patient"
HDL / LDL ratio ("atherogenic index")	Risk classification: <2 „no risk"; 2-4 „increased risk"; >4 "high risk"
TCL / HDL ratio	Risk classification [mg/dl]: ≤2.0 "ideal"; 4.0-6.0 "high"; >6.0 "too high"
HbA1c	Normal values: <5.7; 5.7 – 6.4 prediabetes; >6.4 diabetes
Cholesterol total	200 – 220 mg/dl
HDL	Women: 45 – 65 mg/dl; men: 35-55 mg/dl
LDL	<135 mg/dl
Triglycerides	<150 mg/dl

Table 2: Body Mass Index (BMI) of collective (n=56)

Category	**BMI range**	**Number of subjects**	**% of the total study group**	**Total prevalence [%] of the adult German population, males, 2013***	**Total prevalence [%] of the adult German population, females, 2013***
Underweight	17.0-18.4	0	0.0		
Normal weight	18.5-24.9	14	25.0	32.2	44.7
Overweight	25.0-29.9	30	53.6	43.8	29.0
Obesity class 1	30.0-34.9	10	17.8	18.1	23.9
Obesity class 2	35.0-39.9	2	3.6	3.9	5.2
Obesity class 3	40.0+	0	0.0	1.2	2.8

*: Data from (45)

The mean ESC risk score was 4.0% (SD 5.0; range 0-20; n=106, (Figure 3a)). Using the ESC references in (Table 1), 6.6% showed a low risk, 75.5% were moderate, 9.4% were high, and 8.5% were rated very high.

The mean Framingham score was 8.8 (SD 7.2; range 8-23; n=156), indicating a mean 9% risk of myocardial infarction occurring within the next ten years (SD 9.5; range 0.5-40, (Figure 3b)). The differentiation according to risk classes (Table 1) was as follows: 55.4% were low risk, 28.0% moderate, and 16.6% high.

The mean atherogenic index was 2.7 (SD 0.9; range 0.8-6.1; n=165, (Figure 3c)). Using (Table 1) classifications for atherogenic index, 23.6% were at no risk, 70.3% had an increased risk, and 6.1% were high risk. The mean TCL/HDL quotient was 4.1 (SD 1.3; range 1.9-9.2; n=165, (Figure 3d)).

The mean PROCAM score was 38.5 (SD 22.6; range 7-72; n=13), indicating a mean risk for myocardial infarction occurring within the following ten years of 12.5% (SD 15.6; range 0.5-40). However, the number of subjects with data for the PROCAM score was low (n=13). For six subjects, the risk score was low, in four, it was significantly increased, and in three, it was high.

Discussion

Cardiovascular disease is a global public health burden [21,22], and sudden cardiac death (SCD) accounts for 50% of cardiovascular disease (CVD) related deaths [23]. About 80% of SCDs are attributable to an underlying CVD [24]. This indicates that both share similar risk factors (hypercholesterolemia, diabetes, smoking, hypertension, and obesity) [25], [26, 27, 28, 24, 28, 22].

Data indicate that employees deployed to foreign countries suffer from an increased risk [2,4,29,3,7]. Although statistics about the general population in Europe indicate a decrease in SCD since 1990 [30], the topic remains relevant, and controlling risk factors is of central importance.

This study investigated the CVD risk factors of German employees deployed to foreign countries to determine if their risk was higher than that of the general population in Germany (GPG). Different risk scores were included because of their predictive aims for specific outcomes (Table 1) and were based on different populations.

According to the German National Health Report, the GPG suffered from angina pectoris in 5.6% / 8.1% (males/females), cardiac insufficiency in 5.6% / 4.3%, and arrhythmias in 15.7% / 12.1% (31). Respective data for the age groups most relevant to our study are 3.9%, 3.4%, 14.5% (females, 40 to 65 years), and 16.6%, 17.1%. 31.6% (females, >65 years). The respective data for men was 8.3%, 3.9%12.6% (40-65 years), 26.3%, 14.3%, and 31.0% (>65 years) [31].

Age and risk factors

When comparing the total number of employees in Germany, of whom 35.3% were aged 50+ years, our collective was significantly older ($p<0.01$), but nevertheless, the collective's demographics still fit in well with the "typical" deployed employee described above [13]. Smoking is a decreasing tendency in the GPG, with about 16.6% of smokers in 2020 [32]. For the adult population, the respective number was 22.7% [33]. That falls within the scope of our collective.

Concerning the BMI results, our collective's results for obesity classes I to III were similar to the GDG. Nevertheless, the collective had more overweight individuals ($p<0.05$) and fewer subjects in the normal range ($p<0.05$). For the age group most prominent in the current study, the National Health Report for male Germans aged 50-59 (general population) found that 19.4% had an average weight, 60.1% were overweight, and 20.5% were obese. The corresponding figures for the 60-69 age group were 18.7%, 55.4%, and 25.7% [31]. Using BMI as a CVD risk variable, there was a slightly increased risk for our deployed employee collective compared to the GPG.

Systolic blood pressure was above 140 mmHg in 75.3% (n=131) of participants, of which 66.1% had hypertension grade 1 and 9.2% grade 2. Our data included all persons for whom the hypertension was already treated – but obviously, this treatment was insufficient (i.e., poor medication compliance). Half (67/131) of those who were suffering from hypertension had no idea that they were before the appropriate diagnostics were done by occupational medicine. The National Health Report found that 28.0% of the GPG were hypertensive [31], which significantly contrasted with the 75.3% found in our collective ($p<0.05$). However, since blood pressure increases with age (34), our collective's most relevant age groups must be compared with the GPG data. Here, the GPG authors reported that for the age group 50 to 59 years, 36.6% (males) and 32.1% (females) were hypertensive, and for the older group (60 to 69 years), 47.0% and 47.9%, respectively [31]. Other data for the GPG were reported similarly [35]. However, it should be noted that some studies report a higher prevalence of about 65% in males aged 50 to 59 years and nearly 80% in the age group 60 to 69 years, but here, a different collective was investigated (34). Hypertension was significantly more prevalent in our collective compared to the GPG.

Pre-diabetes was reported as about 20% of the GPG [36,37], and in about 25% of the most critical age group of our collective aged 50 to 69 years. However, in data from the National Health Report, which included the age groups 45 to 65 and >65 years, the results were slightly lower (men: 7.8% and 21.4%, respectively) [31]. This portion is significantly lower than in the actual study when comparing the older data in the reference. However, Heidemann et al. (2016) indicated a decrease in prediabetic persons in Germany between 1997 and 2011. Assuming this tendency continued over the following decade, this may explain our significant prevalence. A direct comparison of the collective with the GPG is difficult due to the lack of actual data about the general population, and it is well documented that (pre-) diabetes in other countries, populations, and ethnic groups differ significantly. For the age group of 50 to 59 years, Osorio et al. reported from New York increased HbA1c values in 11.8% of the persons investigated [38]. Significantly increased HbA1c values in 27.4% of the general population were reported from Australia [39], while Caucasian Australians showed increased HbA1c in only 11% [40]. Gruber reported 37% of patients with pre--diabetes in Austria, but because of relevant differences in the study structure, this cannot be compared with our data [41]. Other surveys report about 9% of the GPG suffering from a diagnosed diabetes, but the results differed significantly according to age group, data basis, and survey year [42]. In summary, a valid comparison of whether the risk factor HbA1c for CVD in our study differed from those of the GPG was not possible, although data indicate it is slightly increased. The finding that 26/32 diabetic patients (pre-diabetes included here) had no idea about this problem but were traveling regularly to destinations with low or even missing medical infrastructure is concerning. It emphasises again the need to have an occupational health assessment of fitness to travel and to identify such issues before departure.

The National Health Report gives data about the cholesterol levels of the GPG and lists 41.2% of men aged 50-59 years with high cholesterol (women 33.2%) and 49.8% and 48.8%, respectively, for the age group 60 to 69 years [31]. Compared to these levels, those of the total collective investigated do not differ significantly, but the age group 50-59 years showed significantly higher values ($p<0.05$). HDL values for the GPG are reported to be 55 mg/dl (women 60.9 mg/dl; men 49.1 mg/dl) [31]. Again, the report differed between age groups, but those aged 45 to 64 years and 65 to 79 were particularly important. For men, the authors reported 50.1 mg/dl and 50.3 mg/dl, and for women, 60.2 mg/dl and 60.2 mg/dl, respectively) [31]. About 15 to 20% of the German population showed increased triglyceride levels, mostly diagnosed by incidence [43]. Due to the small sub-collective where this data was available, a valid comparison of this risk factor has not yet been possible.

Risk scores

The study included several risk scores because they are based on different collectives. The Framingham score calculates the risk of myocardial infarction within the next ten years based on a score developed in America in 2001. PROCAM also calculates the risk of a myocardial infarction within the next ten years in a European population. Patients with diagnosed CHD are, by definition, in the high-risk group. The Framingham score also counts diabetics as a high-risk group. The ESC score is broader and includes every fatal cardiovascular risk for the next ten years. The atherogenic index provides a rough idea of whether a patient has an increased risk for atherogenic disease.

All scores from the actual study indicate that there is a significant portion of employees who are potentially at risk of suffering from a cardiovascular event. However, since data for the GPG are scarce, a comparison with the GPG is limited. Data given by Erbel et al. (2008) are within the same range as ours.

Limitations

Future studies should include the measurement of triglycerides to use the PROCAM score for the European population. Many participants in our study had to be excluded from a determination due to food intake before the examination, so only a few values were available. Including the updated SCORE-2 risk assessment could be an advantage because it is based on actual data, assesses country-specific risk that is relevant to the population studied here, and considers age more remarkably [44]. Future studies may also include lifestyle parameters and social status since both are known to influence the risk of cardiovascular events. However, these limitations do not contradict the main conclusion of this study since its goal was a general comparison of the risk between Germans working abroad and the GPG.

Conclusion

A significant number of employees deployed to foreign countries are at risk for cardiovascular events. Data indicate this risk may be higher than in the general German population. Prevention and, if necessary, early diagnosis of such diseases is particularly important for people sent to regions with poor medical infrastructure. Occupational medicine should address these topics before the deployment of employees, especially for those with a higher risk aged 40 to 65+ and for males.

Key learning points

What is already known about this subject

Data available focus military personnel. Data on cardiovascular risk among civilians (business people, workers, etc.) deployed to low-income countries is largely lacking.

What this study adds

Compared with the general population of similar age the employees deployed to low-income countries show a higher risk concerning all factors investigated.

What impact this may have on practice or policy

To reduce the cardiovascular risk of employees deployed to low-income countries individual risk factors and lifestyle during deployment should be addressed by any kind of preventive strategy in occupational medicine.

Declaration of competing interests

No author has any competing interests. The study was conducted with funding from our institute; there was no external funding whatsoever. Data are available on request.

Author contributions

Thomas Küpper: study design, data collection, statistics, manuscript

Travis Heggie: study design, manuscript, manuscript revision

Bianca Hartmann: study design, literature research, data collection, manuscript revision

Klara Arns: manuscript revision

Audry Morrison: literature research, manuscript revision

Andreas Werner: literature research, manuscript revision

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