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Association between reported work in cold environments and stroke occurrence in the CONSTANCES cohort: a prospective study

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ABSTRACT

Objective Cold environments are a potential risk factor for stroke. The aim of this study was to investigate the association between performing work tasks in cold environments and the occurrence of a first stroke event.
Methods From the French population-based cohort CONSTANCES ('*Cohorte des consultants des Centres d'examens de santé*' in French), we collected data from baseline questionnaires along with medical interviews on cardiovascular risk factors and reported exposure to cold temperatures (<10°C) at work. Exposures were categorised as rare (<2 hours/day), often (≥2 and <4 hours/ day) and almost always (≥4 hours/day). Incidence of stroke was retrieved from the French National Health database. Bivariate and multivariable logistic regression models were used to assess the association between working in cold environments and the incidence of stroke. Stratified analyses on stroke types were also conducted.
Results There were 160 782 participants and 224 strokes (168 ischaemic and 76 haemorrhagic) included in our study. No significant increase in stroke was found for working in cold environments; the adjusted OR for often or almost always exposed was 1.14 (95% CI 0.46 to 2.84).
Conclusions This study did not reveal a significant excess risk of stroke for occupational exposures to low temperatures. Further studies are needed to better assess the effect of preventive measures and very low temperature on occurrence of cardiovascular diseases.

STRENGTHS AND LIMITATION OF THIS STUDY

⇒ This study presents data from a large population-based cohort of more than 160 000 participants.
⇒ Incident stroke data were prospectively collected, thanks to a linkage between the CONSTANCES co-hort and the National Health Database.
⇒ Exposure to cold at work was self-reported by par-ticipants at the baseline questionnaire.
⇒ The main limitation of this study is the low number of participants who reported being exposed to cold in their work, particularly in the highest exposed group.

ambient temperatures.[6] A Swedish study of 194 501 construction workers found a minor excess risk of stroke mortality in the coldest living and working areas, but not significant.[7] However, no studies specifically focused on the effect of cold environments at work on stroke incidence while adjusting for cardio-vascular risk factors. Our objective was to access a large population-based cohort to investigate the risk of stroke occurrence in relation to cold exposure while working in low-temperature environments.

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INTRODUCTION

Stroke is a devastating, though largely preventable, health condition.[1] While several studies have suggested the possible role of cold temperatures in the occurrence of cerebrovascular disease, there is a paucity of research about the effect of working in cold conditions on stroke.[2–5] Studies of activities in extreme conditions or in prolonged expo-sure to cold seem to find a modest but signif-icant effect on the occurrence of stroke.[6 7] A Chinese study conducted between the years 2003 and 2014 found a significant risk of intracerebral haemorrhage (adjusted rela-tive risk 1.16, 95% CI 1.04 to 1.30) for cold

METHODS

The French CONSTANCES ('*Cohorte des consultants des Centres d'examens de santé in French*') study is a population-based cohort that began in 2012.[8] Participants were randomly selected adults aged 18–69 years. Data were compiled from self-administered questionnaires and medical health exam-inations, which were conducted at affiliated health-screening centres. The data were then linked to stroke incidence information retrieved from the French National Health Insurance records. All study participants gave informed consent prior to enrolment. The study timeline included subjects from study

inception up to the year 2019 (the date of data extraction) and for whom data on stroke status were available (from 2012 to 2018).

Age, sex, smoking, occupation and work exposure were retrieved from the baseline self-administered questionnaires. Age was considered as a continuous variable and the other variables were categorised as follows: sex (male or female), smoking habits (not smoking, current or former smoker <30 pack-years, current or former smoker ≥30 pack-years) and occupation according to the French occupational and social classification (manager/chief executive officer/skilled jobs, high-skilled white-collar jobs, low-skilled white-collar jobs and blue-collar jobs). Exposure to cold temperature at work was assessed as follows: 'is the temperature at your workplace (when you are not outside) really low (less than 10 degrees)?' Participants had to answer with a duration of work exposure to low temperatures evaluated in three categories: (1) no exposure/almost never or rarely (less than 2 hours/day, also the reference category); (2) often (2–4 hours/day); and (3) almost always or always (more than 4 hours/day). Each participant had a medical interview completed by a physician that included history of stroke (all subtypes together) and age of occurrence, diabetes (yes vs no), history of high blood pressure (yes vs no), dyslipidaemia, whether hypercholesterolaemia or hypertriglyceridemia (yes vs no), family history of cardiovascular events (yes vs no) and body mass index (continuous variable).

Strokes were defined using the principal diagnosis recorded in the National Health Data System. International Classification of Diseases, 10th Revision (ICD-10) codes used were I60–I64. Only the first reported stroke was considered. Cases of stroke occurring before participants filled out the baseline questionnaire were not included and participants with a history of stroke were also excluded. Haemorrhagic and ischaemic strokes were defined by codes from ICD-10.

After analyses to describe population characteristics of the study sample, logistic regression models, with and without adjustment for confounding variables, were used to calculate the ORs for the associations between cold temperatures and the incidence of stroke. Stratified analyses based on stroke type (ischaemic and haemorrhagic strokes) were also conducted. Statistical analyses were performed using SAS V.9.4.

Patient and public involvement

Patients or the public were not involved in the design, conduct, reporting or dissemination plans of our research.

RESULTS

Our sample contained 162 434 individuals with 1652 excluded due to a history of stroke at the time of the baseline questionnaire, leaving a final sample of 160 782 eligible participants. Among them, 244 had an incidence of stroke (168 ischaemic and 76 haemorrhagic strokes) during the study period. A descriptive characterisation

of the cohort at baseline has already been made elsewhere.[8 9] Approximately 2.8% of participants (n=4439) reported being exposed to cold temperature at work for more than 2 hours a day.

As expected, sex, age, diabetes, body mass index, dyslipidaemia and smoking habits were associated with stroke. However, in crude and adjusted models for occupation and cardiovascular risk factors, working in cold conditions was not significantly associated with stroke (adjusted OR of 1.14, 95% CI 0.46 to 2.84), though CIs were large due to the low number of cases in the exposed group. The Hosmer-Lemeshow fit test for the total multivariate model was not significant (p=0.08). These results were similar in models stratified on stroke type (table 1).

DISCUSSION

In this study of a large population-based cohort, we found no association between exposure to working in cold environments and the occurrence of stroke. As a distinction, to our knowledge, this is the first study to account for cardiovascular risk factors in this kind of investigation.

These results are consistent with the occupational findings in the Swedish studies that did not find any excess risk of mortality from stroke, in cold conditions, among male construction workers with normal blood pressure (but found an excess of mortality from myocardial infarction).[7] Other studies on environmental exposure to cold environments show only weak effects, with an attributable fraction for stroke lower than 20%.[3] Li *et al* found an significative increase risk of intracerebral haemorrhage for cold temperature exposure but not for ischaemic stroke.[6] This study did not particularly focus on an occupational setting and so, preventive measures against cold may be less likely to be used. Moreover, our study may lack power to be able to assess accurately association according to stroke subtype.

The pathophysiology between cold and the cardiovascular effects mentioned (activation of the sympathetic and endocrine nervous systems leading to changes in blood pressure)[2 6] may exist but are possibly counterbalanced by the effects of selection of the most acclimated workers and by protective measures implemented in the workplace.

The main limitation of this study is the low number of participants who reported being exposed to cold in their work, particularly in the highest exposed group. This may be a cause of lack of power, however, proportion of stroke cases in the intermediate exposition group is similar to the reference group. Exposure to cold temperature is not frequent in France. A report by the Ministry of Labour found that that approximatively 6.1% of workers were exposed to work in cold temperature (<15°).[10] In addition, stroke is a relatively rare event, and though we included data from 2012 to 2018, only 244 first cases of stroke were identified. This number is the same order of magnitude as the standardised rate of hospitalisation for stroke in France, which was of 66.0 per 100 000 inhabitants for men

Table 1 Univariate and multivariable analyses describing associations between working in cold conditions and stroke

	Total	Cases (n)	Proportion of cases (per 10 000 people)	Crude OR (95% CI)	Adjusted OR (95% CI)*
All stroke					
Working in cold conditions†					
No or rarely (<2 hours/day)	156 343	239	15	1	1
Often (2–4 hours/day)	2585	4	15	1.01 (0.38 to 2.72)	1.14 (0.46 to 2.84)
Almost always (≥4 hours/day)	1854	1	5	0.35 (0.05 to 2.51)	
Type of profession					
Manager, chief executive officer, skilled jobs	49 303	72	15	1	1
High-skilled white-collar workers	43 418	74	17	1.17 (0.84 to 1.62)	1.16 (0.83 to 1.61)
Low-skilled white-collar workers	37 381	39	10	0.71 (0.48 to 1.05)	0.93 (0.62 to 1.40)
Blue-collar workers	14 759	31	21	1.44 (0.94 to 2.19)	1.19 (0.77 to 1.84)
Ischaemic stroke					
Working in cold conditions†					
No or rarely (<2 hours/day)	156 343	165	11	1	1
Often (2–4 hours/day)	2585	2	8	0.73 (0.18 to 2.96)	0.91 (0.29 to 2.93)
Almost always (≥4 hours/day)	1854	1	5	0.51 (0.07 to 3.65)	
Type of profession					
Manager, chief executive officer, skilled jobs	49 303	54	11	1	1
High-skilled white-collar workers	43 418	44	10	0.93 (0.62 to 1.38)	0.95 (0.64 to 1.43)
Low-skilled white-collar workers	37 381	31	8	0.76 (0.49 to 1.18)	1.10 (0.69 to 1.75)
Blue-collar workers	14 759	23	16	1.42 (0.87 to 2.32)	1.16 (0.70 to 1.91)
Haemorragic stroke					
Working in cold condition†					
No or rarely (<2 hours/day)	156 343	74	5	1	1
Often (2–4 hours/day),	2585	2	8	1.63 (0.40 to 6.66)	1.82 (0.42 to 7.79)
Almost always (≥4 hours/day)	1854	0	0	Not estimable	
Type of profession					
Manager, chief executive officer, skilled jobs	49 303	18	4	1	1
High-skilled white-collar workers	43 418	30	7	1.89 (1.06 to 3.40)	1.72 (0.95 to 3.11)
Low-skilled white-collar workers	37 381	8	2	0.59 (0.25 to 1.35)	0.61 (0.26 to 1.44)
Blue-collar workers	14 759	8	5	1.49 (0.65 to 3.42)	1.31 (0.55 to 3.10)

*Adjusted for type of profession, sex, age, body mass index, high blood pressure, diabetes, dyslipidaemia, familial history of cardiovascular disease and smoking.
†Due to a low number of events in some cells, the variable 'working in cold conditions' was categorised in two categories in the multivariable analyses: no or rarely (<2 hours/day—referent category) and often and almost always were merged into one (ie, >2 hours/day).

≤65 years and 36.4 per 100 000 inhabitants for women ≤65 years in 2014.[11]

Temperature exposure was self-reported at the time of the completion of the questionnaire and could not differentiate very low temperature (<0°C). We were also unable to distinguish globally good jobs from poor working conditions that lacked workplace protective measures; nevertheless, we were able to capture perceived temperature, and this study population had jobs that were relatively stable with long tenure, allowing us to have some confidence in our findings. A country with extreme climates would also be an important

exposure factor for workers that may spend most of their time outdoors, for instance. The country in this study typically has a moderate climate that might rarely expose workers to harsh outdoor conditions. Finally, although details surrounding the circumstances of the strokes and radiological diagnoses were not available for this study, the multiple follow-ups, medical interviews, longitudinal design of the cohort and linkage to the national health database ensured some robustness to the results. Though confidence intervals were large, the study's design allowed assessment of the associations on a populational level while considering important confounders which

were significant in the models, giving confidence in the credibility of the results.

Individual protective equipment could possibly prevent risks of stroke, but their role is not understood enough. Though there were no data available on whether workers actually wore their protective equipment, equipment for cold temperature is usually well worn in France.

In conclusion, despite moderate evidence of the association elsewhere,[6 7] this study shows no excess risk of stroke due to cold working conditions. Further studies are needed to better assess the effect of cold on stroke risk in very low temperature work environments, with or without prolonged exposure.

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