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Factors associated with morbidity during the 2003 heat wave in two population-based cohorts of elderly subjects: PAQUID and Three City

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Abstract *Introduction* France was affected in early August 2003 by a heat wave with an exceptional health impact. Many studies on mortality were conducted but few data are available on morbidity. The objectives of this study were to describe the impact of the 2003 heat wave in the general population of elderly people and to determine individual factors associated with morbidity. *Methods* A cross-sectional study nested in two prospective cohorts, the PAQUID and the Three-City (3C) studies, was performed. The sample included 2295 subjects from the general population, aged 67 and over who were interviewed by a phone questionnaire to complete data available in the database of the two cohorts. Two variables assessing morbidity (felt by the person and objectively observed) were created. Relationship between morbidity and individual factors were explored in univariate analyses; then multiple logistic regressions were conducted. *Results* During the heat wave, 8.8% of the subjects felt a deterioration of their health, and 7.8% declared an objective morbid outcome. In the univariate analyses, many factors were associated with morbidity. After multiple adjustments, few associations were still observed but some factors were associated with a decreased risk (presence of a bathroom, dressing lighter than usually) or an increased risk (stopping usual activities, presence of chronic diseases). *Conclusion* This study showed a non-negligible impact of the 2003 heat wave in term of felt and objective morbidity. Several individual factors were shown to be associated with morbidity and should be taken into account for the elaboration of prevention plans.

Keywords Elderly · Heat wave · Morbidity

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Introduction

Europe was affected in early August 2003 by a heat wave during which temperatures records were broken, and France was one of the most affected countries. Between August 1st and 18th, temperatures reached 35°C and over in more than 60% of the meteorological stations and even 40°C and over in 15% of them. The impact in term of public health was exceptional since about 15,000 excess deaths occurred between August 1st and 20th (Fouillet et al. 2006). Mortality excess was estimated to 20% for people aged 45–74 years, 70% for the 75–94 year age group, and 120% for people over 94 years (Pirard et al. 2005), and this greatest impact among the elderly was also observed in others European countries (Kosatsky 2005).

Many studies were conducted to describe the aetiology of these excess deaths and their risk factors in the general population (Canoui-Poitrine et al. 2006; Institut de veille sanitaire 2004a), at the hospital (Davido et al. 2006) or in nursing homes (Holstein et al. 2005; Institut de veille sanitaire 2005b), and most of them focused on elderly.

However, very little is known about morbidity attributable to the heat wave, but the few studies conducted through several indicators (emergency admissions, home medical visits and ambulance services) suggested an impact in France (Vandentorren et al. 2003; Institut de veille sanitaire 2005a) and Spain (Trejo et al. 2005).

In that context, the aim of this study was to quantify the impact of the 2003 heat wave among elderly people from two population-based cohorts (the PAQUID and the 3C studies) in term of morbidity (general feeling and objective events reported by the subject), and to determine factors associated with this morbidity.

Methods

This cross-sectional study is nested in two prospective cohorts of elderly people: The PAQUID (Personnes Agées QUID) study (Dartigues et al. 1992) and the Three-City (3C) study (3C Study Group 2003).

General presentation of the two cohorts

The PAQUID cohort is a prospective study of 3777 elderly people aged 65 and over, representative of community residents in Gironde and Dordogne, two areas in south-western France. Its general aim was to study risk factors of cerebral and functional ageing (Dartigues et al. 1992). Subjects were seen at home by a psychologist in 1998 and were regularly seen.

The Three-City (3C) study is a cohort of 9294 community-dwellers aged 65 years and over randomly sampled from the electoral rolls of three French cities: Bordeaux (n = 2104), Dijon (n = 4931), and Montpellier (n = 2259). Its general aim was to identify vascular risk factors associated with dementia (3C Study Group 2003). Subjects were recruited in 1999–2001 and were also regularly seen.

Inclusion criteria

The study population was composed of all the subjects alive at the beginning of the heat wave and living at home during the study period, i.e. August the 1st–15th. For the PAQUID study, all the subjects were eligible. For the 3C study, only subjects living in Bordeaux and Dijon were recruited for logistic reasons.

According to the inclusion criteria, 1089 subjects from the PAQUID study were eligible. Among them, 152 (13.7%) refused to participate and 58 (5.2%) were withdrawals. The sample was therefore constituted of 879 subjects from this cohort. Concerning the 3C study, 1838 subjects were eligible but 323 (17.6%) refused the interview and 99 (5.4) were not contactable; 1416 subjects were therefore included.

Data collected

The initial database of each cohort contained many variables including socio-demographic factors, social support and network, living conditions and habits, subjective and objective health measurements, depressive symptomatology, current symptoms and diseases, autonomy in the activities of daily living, cognition assessed through a series of psychometric tests including the Mini Mental State Examination (Folstein et al. 1975), and diagnosis of dementia according to the NINCDS-ADRDA criteria (McKhann et al. 1984).

Because further data were needed to explore morbidity due to the heat wave, phone interviews were conducted from September to December 2003 by specifically trained interviewers who fulfilled a standardized questionnaire to collect:

- behavioural adaptations during the heat wave: having baths or showers, drinking, use of cooling techniques (ventilator, brumisator), ventilation of the house, time of go out, etc;
- current symptoms and diseases (respiratory symptoms, endocrine disorders, vascular, hepatic, kidney, neurological and psychiatric diseases), current treatments, resort to health carriers during the heat wave;
- lethal and morbid outcomes during the heat wave such as dizzy turns, fallings, loss of balance, and death;
- information on autonomy available in the initial database was completed by questions about ability to go shopping, restriction to the house or to bed, and use of home helper or home medical care;
- characteristics of the accommodation: number of rooms, presence of a bathroom, floor number, possibility to ventilate, presence of air conditioning and bedroom.

Morbidity assessment

Two variables were created: one to assess morbidity felt by the person, and the other one to assess objective morbidity events.

- Felt morbidity was assessed by asking subjects the following question: “Did you feel a deterioration of your health during the heat wave?”
- Objective morbidity was defined by the occurrence, during the heat wave, of a morbid outcome declared by the subject or his close relative: dizzy spell, fall, loss of balance, hospitalization or death.

Statistical analyses

A description of the general characteristics of participants and of the occurrence of felt and objective morbidity events was first performed.

Relationships between individual factors and morbidity outcome were first estimated in univariate analyses using chi-square and student t tests. Then, variables associated with morbidity with a P-value < 0.25 were taken into account simultaneously in multivariate models with forward stepwise logistic regressions.

Because of differences between the two studies in term of variables contained in the initial databases and subject's recruitment, analyses were performed separately for the PAQUID and the 3C study.

Statistical analyses were performed using the SAS software.

Results

Characteristics of the subjects are described in Tables 1 (for the PAQUID study) and 2 (for the 3C study), which also presents the associations between these characteristics and felt and objective morbidity in univariate analyses. All the subjects from the 3C study answered by themselves; in the PAQUID study, 13 informers were interviewed (i.e. 1.5%) because the subjects were not able to answer the questionnaire.

Mean age was 78.3 years for 3C participants, and 86.3 years for PAQUID participants, and about two thirds of the subjects were women in both cohorts.

During the heat wave, 8.8% of the subjects from the two cohorts felt a deterioration of their health, and 7.8% declared an objective morbid outcome. Morbidity was higher in the PAQUID than the 3C study, as shown in Fig. 1. Indeed, 104 subjects (11.8%) from this cohort declared that they had felt a deterioration of their health and 95 (10.8%) declared an objective morbid event, whereas in the 3C study they were 101 (7.1%) and 85 (6.0%) respectively.

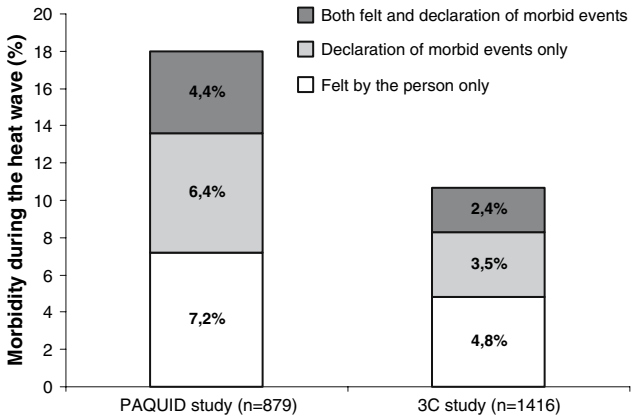

Fig. 1 Occurrence of morbidity during the heat wave among subjects from the PAQUID study (n = 879) and 3C study (n = 1416)

Among the 95 subject from the PAQUID study who declared an objective morbid event, the most frequent outcomes were losses of balance (54.3%) and dizzy spells (43.6%), then falls (27.7%) and hospitalizations (15.8%), and 4 subjects died (4.2%). In the 3C cohort, the 85 subject who declared an objective morbid event also often declared dizzy spells (56.5%), but fewer were hospitalized (5.9%), had losses of balance (28.2%) or fell (9.4%), and no one died.

In both studies, age, low educational level and being a woman were factors associated with an increased risk of objective morbidity (Tables 1 and 2). Concerning characteristics of accommodation, the possibility to ventilate the house and the presence of a bathroom were associated with a decreased objective morbidity. Disability was also associated with morbidity since subjects who received health carrier visits, used home delivery service and were disabled for at least one IADL were at higher risk of felt and objective morbidity, although some of these relationships were not significant in the PAQUID cohort. Concerning behavior, subjects who spent time out during the heat wave, especially in the afternoon, and who ventilated their house, whatever the moment, had a decreased risk of morbidity in the 3C study. On the contrary, those who used cooling techniques (atomizer, cold bathes, ventilator, wet linen or light clothes), who dressed lighter than usually and who stopped their usual activities during the heat wave had an increased risk. Lastly, health status of the subjects was strongly associated with the risk of morbidity in both cohorts.

Multivariate analyses were then performed and factors still significantly associated with morbidity after adjustments are presented in Table 3. The nature of factors associated with morbidity was quite different according to the cohort and the type of morbidity considered (felt by the patient or objective morbidity outcomes). As in the univariate analyses, age and educational level were associated with objective morbidity, but only in the 3C study. Presence of a bathroom in the PAQUID study and to dress lighter than usually in the 3C study were associated with a decreased risk of objective morbidity. The time of the day when subjects spent time out was strongly associated with felt morbidity in the PAQUID study; however, no association was observed in the 3C cohort or with objective morbidity.

Stopping usual activities during the heat wave was associated with an increased risk of morbidity in both cohorts, as well as several chronic diseases: asthma and depression were associated with felt morbidity in the 3C study, and respiratory disease, neurological disease, diabetes and cardiovascular disease with objective morbidity in the PAQUID study.

Table 1 Factors associated with morbidity (felt by the patient and objectively observed) in univariate analyses

	n (%)	Felt morbidity			Objective morbidity		
		%*	OR	95% CI	%*	OR	95% CI
Sociodemographic characteristics							
Sex: women	558 (63.5)	12.5	1.4	[0.8–2.5]	10.8	1.0	[0.6–1.5]
Primary educational level	648 (73.7)	10.2	0.7	[0.4–1.1]	9.7	0.7	[0.4–1.1]
Living alone	306 (34.8)	15.0	1.6	[0.9–2.7]	13.7	1.5	[1.0–2.4]
Age: mean (sd)	78.3 (5.0)	–	1.0	[1.0–1.1]	–	1.1	[0.9–1.0]
Characteristics of accommodation							
Possibility to ventilate	818 (93.4)	11.6	1.3	[0.4–4.3]	10.3	0.5	[0.2–1.0]
Living in a top floor apartment	181 (20.7)	13.8	1.2	[0.7–2.2]	10.0	0.9	[0.5–1.5]
Presence of a bathroom	851 (96.8)	8.5	0.3	[0.1–0.9]	8.9	0.3	[0.1–0.8]
Autonomy of the subjects							
Frequency of health carriers visits							
never	435 (49.9)	9.9	1.0	–	9.7	1.0	–
<once a week	104 (11.9)	8.7	0.6	[0.2–1.9]	9.6	1.0	[0.5–2.1]
≥once a week	332 (38.1)	15.4	1.8	[1.1–3.1]	13.0	1.4	[0.9–2.2]
Home delivery service	408 (46.9)	15.0	2.4	[1.4–4.1]	13.9	1.8	[1.1–2.7]
Disability for at least 1 IADL	359 (42.2)	13.9	1.3	[0.8–2.3]	12.9	1.4	[0.9–2.1]
Behaviour							
Time out during the heat wave							
Never	221 (25.4)	18.1	1.0	–	15.4	1.0	–
Less often	431 (49.5)	12.1	0.5	[0.3–0.9]	9.5	0.6	[0.4–0.9]
Often	218 (25.1)	5.5	0.1	[0.0–0.3]	9.2	0.6	[0.3–1.0]
Moment of time out							
In the morning/at night	532 (61.8)	10.3	1.0	–	9.2	1.0	–
In the afternoon	108 (12.5)	8.3	0.4	[0.1–1.5]	10.4	1.1	[0.6–2.3]
Never	221 (25.7)	18.1	2.4	[1.4–4.1]	15.7	1.8	[1.1–2.9]
Ventilation of the house							
In the morning/at night	221 (60.4)	39.8	1	–	34.8	1.0	–
Never	37 (10.1)	18.9	0.9	[0.2–3.9]	21.8	2.3	[1.0–5.3]
In the afternoon	108 (29.5)	9.3	0.9	[0.3–2.3]	9.3	1.1	[0.6–2.3]
Use of refreshments	607 (69.1)	13.3	1.3	[0.7–2.2]	12.5	1.9	[1.1–3.2]
To dress lighter	307 (36.2)	14.7	1.1	[0.6–1.9]	14.7	1.7	[1.1–2.6]
Stopping usual activities	245 (28.3)	19.2	1.8	[1.1–3.1]	16.5	2.1	[1.3–3.3]
Health status							
Asthma	44 (5.4)	6.8	0.3	[0.0–2.5]	19.4	1.9	[0.8–4.2]
Respiratory symptoms	103 (12.1)	18.4	1.2	[0.5–2.7]	26.5	3.6	[2.2–6.0]
Kidney disease	22 (2.6)	13.6	0.8	[0.1–5.8]	28.1	3.2	[1.2–8.4]
Cardiovascular disease	471 (53.8)	15.1	1.4	[0.8–2.3]	14.3	2.2	[1.3–3.4]
Diabetes	54 (6.3)	20.4	1.9	[0.8–4.6]	15.1	1.7	[0.8–3.5]
Neurological disease	48 (5.5)	12.5	1.1	[0.3–3.7]	27.7	3.3	[1.7–6.6]
Dementia	134 (15.2)	6.7	0.5	[0.2–1.2]	11.2	0.9	[0.5–1.8]
Mood disorders	276 (31.7)	17.8	2.2	[1.3–3.7]	17.0	2.1	[1.4–3.4]

Results from simple logistic regressions, PAQUID study (n = 879)

* Percent of subjects from each subgroup who experienced morbidity

Discussion

This study is the first one to focus on morbidity in the general elderly population during the 2003 heat wave in France. It showed a non-negligible impact since 8.8% of the subjects interviewed felt a deterioration of their health and 7.8% experienced an objective morbid event outcome. However, the proportion of subjects declaring a deterioration of their health is not so large regarding the effect that publicity surrounding the increased mortality during the

Table 2 Factors associated with morbidity (felt by the patient and objectively observed) in univariate analyses

	n (%)	Felt morbidity			Objective morbidity		
		%*	OR	95% CI	%*	OR	95% CI
Sociodemographic characteristics							
Sex: women	950 (67.1)	8.5	2.2	[1.2–4.2]	6.9	1.8	[1.0–3.0]
Primary educational level	1285 (91.0)	6.8	0.8	[0.4–1.8]	5.5	0.5	[0.3–0.9]
Living alone	696 (49.3)	7.8	1.9	[1.1–3.1]	6.5	1.7	[1.1–2.6]
Age: mean (sd)	78.3 (5.0)	–	1.0	[1.0–1.1]	–	1.1	[1.0–1.1]
Characteristics of accommodation							
Possibility to ventilate	1329 (94.6)	6.6	0.5	[0.2–1.2]	5.6	0.4	[0.2–0.7]
Living in the top floor	141 (10.1)	10.6	1.6	[0.8–3.3]	5.7	0.9	[0.4–2.0]
Single room	123 (8.8)	9.8	0.7	[0.3–2.1]	16.3	3.5	[2.0–6.1]
Presence of a bathroom	1389 (98.1)	7.1	1.2	[0.2–8.9]	5.9	0.5	[0.1–1.7]
Air conditioning	56 (4.0)	8.9	0.7	[0.2–3.1]	7.1	1.2	[0.4–3.4]
Autonomy of the subjects							
Frequency of health carriers visits							
never	1088 (77.5)	6.1	1.0	–	4.9	1.0	–
$<$ once a week	137 (9.8)	12.4	2.5	[1.3–4.8]	9.5	2.0	[1.1–3.7]
$\geq$ once a week	179 (12.7)	10.1	1.6	[0.8–3.1]	10.6	2.3	[1.4–4.1]
Home delivery service	172 (12.2)	14.0	2.1	[1.1–3.9]	11.6	2.4	[1.4–4.0]
Disability for at least 1 IADL	176 (12.4)	12.5	1.9	[1.0–3.5]	10.2	2.0	[1.2–3.4]
Behaviour							
Time out during the heat wave							
Never	95 (6.7)	15.8	1.0	–	12.6	1.0	–
Less often	923 (65.5)	7.8	0.4	[0.2–0.9]	6.9	0.5	[0.3–1.0]
Often	392 (27.8)	3.6	0.3	[0.1–0.7]	2.3	0.2	[0.1–0.4]
Moment of time out							
In the morning/at night	978 (70.2)	8.0	1.0	–	6.4	1.0	–
In the afternoon	321 (23.0)	2.5	0.4	[0.2–0.9]	2.8	0.4	[0.2–0.9]
Never	95 (6.8)	15.8	2.2	[1.0–4.7]	13.7	2.2	[1.1–4.2]
Ventilation of the house							
In the morning/at night	1134 (82.8)	7.1	1	–	6.2	1.0	–
Never	33 (2.4)	18.2	3.8	[1.4–10.3]	9.1	1.7	[0.5–5.7]
In the afternoon	202 (14.8)	6.9	0.9	[0.5–1.9]	5.9	1.0	[0.5–1.9]
Use of refreshments	1046 (73.9)	8.4	1.8	[0.9–3.5]	6.8	1.8	[0.9–3.2]
To dress lighter	545 (39.0)	11.9	2.9	[1.7–4.9]	7.3	1.4	[0.9–2.2]
Stopping usual activities	583 (41.4)	10.8	2.0	[1.2–3.3]	9.1	2.5	[1.6–3.9]
Health status							
Asthma	151 (10.7)	12.6	2.8	[1.6–5.1]	6.6	1.1	[0.6–2.2]
Kidney disease	606 (42.9)	7.9	5.8	[1.8–18.4]	6.4	1.4	[0.3–6.0]
Cardiovascular disease	731 (51.6)	8.2	1.3	[0.8–2.2]	6.7	1.3	[0.8–2.0]
Diabetes	111 (7.9)	6.3	0.5	[0.2–1.8]	7.2	1.2	[0.6–2.7]
Depressive symptoms	142 (10.3)	19.0	3.4	[1.9–6.1]	10.6	1.9	[1.0–3.5]
Neurological disease	91 (6.4)	4.4	0.2	[0.0–1.7]	12.1	2.3	[1.2–4.6]
Dementia	34 (2.4)	14.7	2.1	[0.6–7.2]	8.8	1.5	[0.5–5.1]

Results from simple logistic regressions, 3C study (n = 1416)

* Percent of subjects from each subgroup who experienced morbidity

heat wave may have had on self reported morbidity. It is to be noted that felt and objective morbidity did not concern necessarily the same subjects, and the majority of those who felt a deterioration of their health did not experience one of the morbid outcomes contained in the questionnaire. This could be due to symptoms of discomfort in heat trigger behavioural adaptation that reduce objective mobidity; and it can explain the inverse relationship between certain factors and these two types of morbidity. However, several individual factors were shown to be associated with

Table 3 Adjusted Odds Ratios and 95% Confidence Interval for morbidity in the two cohorts

	PAQUID study		3C study	
	OR	[95% CI]	OR	[95% CI]
Morbidity felt by the patient				
Living in a top floor apartment	0.1	[0.0–1.0]	3.9	[2.0–7.5]
Presence of a bathroom	0.3	[0.2–0.7]		
Moment of time out				
In the morning/at night	1			
In the afternoon	0.5	[0.1–2.3]		
Never	2.5	[1.1–5.4]		
Stopping usual activities	2.2	[1.1–4.4]		
Possibility to ventilate the house			4.3	[1.8–10.2]
To dress lighter than usually			0.3	[0.1–0.9]
Asthma			3.3	[1.8–6.0]
Depression			2.9	[1.4–5.8]
Morbidity objectively observed				
Age	1.0	[0.9–1.1]	1.1	[1.0–1.1]
Primary educational level			0.5	[0.3–0.9]
Respiratory disease	3.3	[1.9–5.7]		
Neurological disease	3.0	[1.4–6.3]		
Diabetes	1.6	[1.0–2.6]		
Cardiovascular disease	1.8	[1.1–3.0]		
Possibility to ventilate the house	0.4	[0.2–0.9]		
Living in a single room			3.1	[1.8–5.5]
Stopping usual activities	1.9	[1.2–3.1]	2.7	[1.7–4.4]

Results from multiple logistic regressions, PAQUID study (n = 879) and 3C study n = (1416)

morbidity and could be taken into account for the elaboration of prevention plans.

However, our study presents certain limits that should be taken into consideration. First, although the two cohorts are population-based, subjects included in this study could be selected since they accepted to be followed during several years and, especially for the 3C study, to undergo a complete medical examination, with a baseline participation rate of 35% (68.5% in the PAQUID study). Then, the assessment of morbidity was made according to the subjects' declaration and they could have under- or over-estimated the impact of the heat wave, especially for felt morbidity. However, the interest of this variable was to assess the feeling of the subjects that could not be taken into account with a standard medical questionnaire. It is also possible that the subjects may not have remembered their symptoms accurately. Lastly, results should be interpreted with care because of the cross-sectional design of the study which does not allow to determinate risk factors but only factors associated with morbidity. For example, using refreshments or stopping usual activities were associated with an increased risk of morbidity; however, subjects who did not feel well during the heat wave may have been more prone to change their behaviours in order to avoid exposure to heat, and these associations probably hence does not reflect a causal relationship.

Despite these limits, our study allowed to determine individual factors associated with the occurrence of a morbid outcome or feeling in the general elderly population.

First, it showed that some behaviours (spending time out, ventilating the house) were significantly associated with a lower risk of morbidity, suggesting that simple gestures or habits can be counselled to minimise the effects of heat wave on health.

Then, although relationships were different between the two cohorts, chronic conditions were strongly associated with felt and objective morbidity, which confirms that subjects with severe illnesses are frailer and more sensitive to environmental changes and should be particularly watched.

It is to be noted that disability was strongly associated with morbidity in the univariate analyses but not after multiple adjustments, which could be explained by a confusing effect of chronic condition. However, even if disability may be a risk marker rather than a risk factor, it can allow targeting a population at higher risk of morbid outcome and people with functional limitation or who regularly need for health carriers or home delivery services have to be specifically focused on.

Results are quite different according to the cohort and even sometimes contradictory. For example, living in a top floor apartment was associated with higher morbidity in the 3C study whereas it was associated with a decreased risk in PAQUID. Living on the higher floors of multistory buildings was already found to be a risk factor of heatstroke in a case-control study performed in Missouri (Kilbourne et al. 1982), and we can easily understand that people living in a top floor apartment are at higher risk because the temperature is then much higher. The association observed in the PAQUID study could therefore seem to be illogical; however, it could be explained by particular characteristics of accommodation in that cohort, since only a part of the PAQUID cohort live in an urban area whereas all the subjects from the 3C cohort are city-dwellers. In general, differences between the two cohorts may also partly be explained by a generation effect since subjects from the PAQUID cohort are 10 years older in mean. When looking at the morbid outcomes experienced by the subjects from the two cohorts, it is to be noted that losses of balance and falls were notably much more frequent in the PAQUID cohort than in the 3C study, which could traduce a higher loss of both neurological and muscle function among subjects from the PAQUID cohort who are much older. Furthermore, subjects from the PAQUID cohort are cognitively much more impaired than those from the 3C study, which could induce a difference in the indicators of

morbidity that we used since they are based on the subjects' declarations.

Very few studies concerning morbidity during the 2003 heat wave have been conducted and it is therefore difficult to compare our results to the literature. However, studies which estimated risk factors of mortality during the heat wave identified factors which were also found to be associated with morbidity in the present study such as socioeconomic status, autonomy, neurological and psychiatric diseases, characteristics of accommodation and adaptation behaviours (Davido et al. 2006; Fouillet et al. 2006; Holstein et al. 2005; Institut de veille sanitaire 2004b). Concerning morbidity, data on emergency department admissions after the 2003 heat wave in Spain (Trejo et al. 2005) and hospitalizations after the 1995 heat wave in Chicago (Semenza et al. 1999) showed an increase of these indicators in association with the heat wave, but individual risk factors were not focused on. A study performed after an exceptional heat wave in 1993 in four hospitals in Adelaïde, South Australia (Faunt et al. 1995), showed that severity of heat-related diseases was associated with age, cognitive impairment, use of drugs (diuretics or multiple medication) and severe co-existing illnesses, which is quite in agreement with our results.

In conclusion, this study confirmed that the 2003 heat wave had a non-negligible impact in term of morbidity in the general population of elderly subjects, which has to be added to the dramatic excess death previously shown. High risk subjects such as those with co-existing chronic diseases or suffering from disability should be identified and targeted by the prevention plans. Furthermore, it appeared that simple behaviours such as choosing the right moment to go out or ventilate the house can reduce the risk of health deterioration attributable to heat among elderly people, which suggests a possible effectiveness of preventive measures. Since summer 2004, a heat health watch warning system has been implemented in France as in other countries (Mastrangelo et al. 2006), including collection of meteorological and health data and a preventive action plan for each region of the country (Laaidi et al. 2004). In that context, rapid identification of high risk subjects is one of the most important criteria for the success of such a system because of the short delay that may elapse between the occurrence of high temperatures and deterioration of the heath or even death (Basu and Samet 2002).

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