

Level of dependency: a simple marker associated with mortality during the 2003 heatwave among French dependent elderly people living in the community or in institutions

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Abstract

Background: in France, the August 2003 heat wave was responsible for considerable excess mortality among the elderly. We wonder whether the dependency level could be a marker of the risk for mortality during this heat wave.

Methods: retrospective cohort study of deaths that occurred between 1 and 20 August 2003, conducted in five departments in the Paris area (Ile-de-France) among the beneficiaries of the Allocation personnalisée d'autonomie (APA), a stipend specifically allocated to dependent subjects ≥ 60 years of age. Their dependency level was determined by the GIR group (defined by the French law) used to fix the APA amount. Subjects' GIR group classification and demographic variables were obtained from departmental administrative files.

Results: among the 31,603 APA beneficiaries alive on 31 July 2003, 16,779 were community dwellers and 14,824 lived in institutions. Between 1 and 20 August 2003, 858 subjects died: 300 community dwellers and 558 institutionalised (mortality rates of 2.7, 1.8 and 3.8 per cent, respectively). Independent risk factors for mortality were: age, sex and GIR group in community dwellers; age, GIR group and living in a region highly exposed to heatwave mortality for institutionalised elderly; independent factors for mortality were age, sex, GIR group, type of residence (institution/community), living in a region highly exposed to heatwave mortality and income for the overall population.

Conclusion: the dependency level was associated with mortality during the 2003 heatwave in France, especially for elderly community dwellers. Dependency might help identify high-risk subjects and guide targeted prevention measures against heatwave-associated mortality.

Keywords: *heatwave, mortality, dependency, elderly*

Introduction

Several studies documented that heatwaves have deleterious consequences on health and lead to excess mortality,

especially among the elderly [1–7]. Since most heatwave-related mortality can be prevented by simple measures, the recognition of its risk factors is of crucial importance to

help target prevention towards high-risk individuals [8]. In France, the heatwave of August 2003 was a huge public health disaster, responsible for considerable excess mortality estimated at 14,802 deaths, as compared to mortality observed during the same periods of the previous 3 years [9–11]. To date, that heatwave has been the most lethal one documented. Elderly individuals were the principal victims, since 82 per cent of the excess of mortality was observed in subjects ≥ 75 years of age [9, 11]. First studies of the 2003 heatwave showed that in France, excess mortality was directly associated to age and climatic conditions, with large interregional differences [9–13].

Since loss of autonomy is a potent determinant of vulnerability in the elderly and might directly impair the ability to adopt appropriate behaviour of self protection against heat, we hypothesised that the level of dependency could be a marker for risk of death among older individuals with impaired autonomy. This study was conducted to investigate whether the dependency level helped to detect mortality in a high-risk population during the 2003 heatwave in France. For this purpose, we studied the beneficiaries of the Allocation personnalisée d'autonomie (APA), a stipend specifically established for persons ≥ 60 years of age with moderate to severe dependency.

Methods

Selection of the subjects

The study was conducted in Ile-de-France, a French region which was very severely affected by the 2003 heat wave [10, 11, 13]. Authorities of the eight departments of this region were asked to participate in the study; two of them declined and another failed to extract reliable data from their electronic database because of technical problems. Therefore, the study concerned the five remaining departments of Ile-de-France region (Essonne, Seine et Marne, Seine Saint Denis, Val d'Oise, Yvelines). Information on the APA beneficiaries of those who were alive on 31 July 2003, were obtained from the administrative files of each participating department. The APA is a stipend allocated exclusively to elderly individuals, according to dependency level and income. Upon request by the subject or his or her caregiver, APA is dispensed by the department administration to help them to pay for professional assistance to live at home or the fees for institutional care.

Definitions and data collected

The deaths of APA beneficiaries that occurred between 1 and 20 August 2003, the period selected to analyse the consequences of the 2003 heatwave in France [9–11] were recorded. Death/survival during the heatwave was used as the independent variable.

The following parameters were extracted from the database for each subject: age, sex, marital status (married/unmarried/widowed), the type of residence (community/institution), the department of residence, income (evaluated as quartiles), and the level of dependency. The dependency level of each individual applying for APA was determined by trained personnel of the department or institutions using the AGGIR scale defined by French legislation [14, 15]. The 15 items of the AGGIR scale are shown in the table Appendix 1 in the supplementary data on the journal website (<http://www.ageing.oxfordjournals.org/>). This scale is used to assign subjects to one of six GIR groups, each corresponding to a length of assistance time required to help the individual to accomplish daily living activities: GIR 1 corresponds to very severe dependency, GIR 2 to severe dependency, GIR 3 to moderately severe dependency, GIR 4 to moderate dependency, GIR 5 to mild dependency and GIR 6 to the absence of dependency [15]. APA is attributed only to persons classified in GIR groups 1 to 4: the lower the GIR group number, greater the amount of assistance required. Each beneficiary's dependency level was assessed shortly before APA attribution in order to determine the GIR group and sum accorded. Due to APA attribution, the process of GIR group determination is carefully supervised by departments. Dependency was reassessed when beneficiaries or caregivers noted substantial deterioration that led to modification, if necessary, of the GIR group and the sum allocated. For our analysis, the last GIR group determined before 31 July 2003 was retained.

Because some beneficiaries resided in a department different from that providing the APA, we investigated a possible bias associated with regional heterogeneity of the heatwave-related mortality observed in France. To do so, we defined exposure to heatwave-related mortality in the region of residence using a 3-grade scale according to the tertiles of the heatwave-related excess mortality calculated by Hémon and Jouglar for the French regions [9, 11].

The total number of deaths occurring between 1 and 20 August 2003 recorded for the whole population in each department and ages at death, were obtained from the departmental administration. Data from the 1999 general population census were used to calculate mortality rates. Because no financial aid was accorded to subjects assigned to GIR groups 5 and 6, who were part of the general population, general population mortality rates were considered as an estimate of the mortality rate among independent population. However, the relative risks of death among the APA beneficiaries were calculated versus GIR 4.

Statistical analyses

Factors associated with mortality were analysed separately for community dwellers, institutionalised elderly and the entire cohort. First, relationships between potential risk factors and mortality were evaluated using chi-square tests for categorical variables and Student's *t*-test for continuous variables. Second, the factors identified as being associated with mortality according to our univariate analysis with

Table 1. Characteristics of the APA beneficiaries in five Ile-de-france departments, according to the type of residence

Parameter	Community-dwellers (<i>N</i> = 16,780)	Institution residents (<i>N</i> = 14,824)	<i>P</i>
Age (yr, mean \pm SD)	82.0 \pm 9.2	84.6 \pm 9.4	<0.0001
Women	12,777 (76)	11,553 (78)	<0.0001
Department providing APA			<0.0001
Essonne	2,732 (16)	3,211 (22)	
Seine et Marne	3,314 (20)	2,495 (17)	
Seine Saint-Denis	3,858 (23)	3,000 (20)	
Val d'Oise	3,262 (19)	1,811 (12)	
Yvelines	3,614 (22)	4,307 (29)	
Income (quartiles) ^a			<0.0001
1st (lowest)	4,655 (32)	2,774 (20)	
2nd	2,613 (18)	2,605 (19)	
3rd	3,128 (22)	3,240 (23)	
4th	4,038 (28)	5,427 (39)	
GIR group ^a			<0.0001
1. (very severe dependency)	895 (6)	2,469 (17)	
2. (severe dependency)	3,933 (25)	5,951 (42)	
3. (moderately severe dependency)	4,003 (25)	2,560 (18)	
4. (moderate dependency)	6,901 (44)	3,249 (23)	
Marital status ^a			<0.0001
Unmarried/widowed	7,447 (70)	8,040 (88)	
Married	3,268 (31)	1,046 (12)	
Residential exposure to heatwave-related mortality ^a			
Low + intermediate	230 (2)	1,904 (13)	0.001
High	13,805 (98)	12,325 (87)	
Deaths during the heatwave	300 (1.78)	558 (3.76)	<0.0001

Values are no. (%) unless stated otherwise.

^a Some values are missing because some of the applications were still being evaluated.

$P < 0.10$ were subjected to stepwise multivariate logistic regression analysis. All computations were performed with SAS V8 software. $P < 0.05$ was considered significant.

Results

The characteristics of the 31,603 APA beneficiaries (24,330 women and 7,273 men) eligible for the study according to the type of residence are shown in Table 1. As expected, institutionalised beneficiaries were significantly older, less frequently married and more severely dependent than community dwellers. Among APA beneficiaries, 858 (2.7 per cent) died between 1 and 20 August 2003, and mortality was higher for institutionalised beneficiaries than community dwellers (3.8 per cent versus 1.8 per cent, $P < 0.0001$).

Univariate and multivariate analyses of the factors associated with mortality of APA beneficiaries living in the community or an institution are shown in Tables 2 and 3, respectively. Among the community dwellers, independent factors associated with mortality were GIR group, age and sex. Among institutionalised subjects, independent factors were GIR group, age, and living in a region highly exposed to the heatwave-related mortality. Adjusted odds ratios for mortality varied significantly according to the GIR group with a dose-response effect for both institutionalised and community-dwelling subjects, with the mortality rate rising as the level of dependency increased.

Univariate and multivariate analysis for the overall population showed that the independent factors related to mortality were age, sex, GIR group, type of residence (institution/community), living in a region exposed to heatwave-related mortality and income (please see Appendix 1 in the supplementary data on the journal website: <http://www.ageing.oxfordjournals.org/>).

For the general population of the five participating departments, 3,212 deaths were recorded of subjects ≥ 65 years of age (mortality rate, 0.47 per cent) during the study period, distributed as follows: 558 were 65–74 years old (mortality rate, 0.14 per cent), 1168 were 75–84 years old (mortality rate, 0.58 per cent) and 1486 ≥ 85 years old (mortality rate, 1.57 per cent. Deaths recorded among APA beneficiaries > 65 years old were 26.4 per cent of the total number of deaths recorded during the study period in the five departments (16.8, 23.3 and 31.9 per cent in subjects aged 65–74, 75–84 and 85 or more, respectively). Mortality rates as a function of age for APA beneficiaries, according to GIR group and type of residence, and for the general population as shown in Appendix 2 in the supplementary data on the journal website (<http://www.ageing.oxfordjournals.org/>).

Discussion

The results of this study show that during the heatwave of 2003, the dependency level was a significant and strong

Table 2. Univariate and multivariate analyses of the factors associated with mortality of community-dwelling APA beneficiaries during the 2003 heatwave

	Deceased (<i>n</i> = 300)	Alive (<i>n</i> = 16,480)	Mortality rate (per cent)	Univariate <i>P</i>	Adjusted odds- ratios (95% CI) ^a	<i>P</i>
Age (yr, mean ± SD)	83.7 ± 9.1	82.0 ± 9.2		0.0015	1.015 (1.005–1.025)	0.0035
Sex:						
Men	100 (33)	3,899 (24)	2.5	0.0001	1.52 (1.16–2.01)	0.0029
Women	200 (67)	12,577 (76)	1.6		1	
GIR group						
1	32 (11)	863 (6)	3.6	0.0001	4.75 (3.01–7.50)	0.0001
2	111 (40)	3,822 (25)	2.8		2.96 (2.11–4.14)	
3	64 (23)	3,939 (25)	1.6		1.72 (1.18–2.49)	
4	72 (26)	6,829 (44)	1.0		1	
Marital status:						
Unmarried, widowed	124 (64)	7,323 (70)	1.7	0.11		
Married	69 (36)	3,199 (30)	2.1			
Income (quartiles):						
1st (lowest)	85 (33)	4,570 (32)	1.8	0.73		
2nd	46 (18)	2,567 (18)	1.8			
3rd	60 (24)	3,068 (22)	1.9			
4th	64 (25)	3,974 (28)	1.6			
Department providing APA						
Essonne	53 (18)	2,679 (16)	1.9	0.33		
Seine et Marne	54 (18)	3,260 (20)	1.6			
Seine Saint-Denis	57 (19)	3,801 (23)	1.5			
Val d'Oise	62 (21)	3,200 (19)	1.9			
Yvelines	74 (25)	3,540 (21)	2.1			
Residential exposure to heatwave related mortality						
Low + intermediate	1 (0.4)	229 (1.7)	1.2	0.14 ^b		
High	258 (99.6)	13,547 (98.3)	1.9			

Values are no (%) unless stated otherwise.

^a All the variables with *P* < 10 in the univariate analysis were included in the model.

^b Fisher's exact test.

marker for mortality of elderly French subjects with impaired autonomy, independent of age, sex, marital status, the type of residence (community/institution) and residing in a region exposed to high heatwave-related mortality. The dependency level can be used to identify high-risk individuals during heatwaves.

Our findings are in agreement with our hypothesis that the dependency level might be related to an increased vulnerability to heatwaves. Our conclusion is in accordance with the findings of Semenza *et al.* [5] who conducted a case control study on the 1995 heatwave in Chicago and found that to be confined to bed was the strongest risk factor for mortality with an adjusted odds ratio of 8.2 (95% CI: 3.1–22.0), independently of other risk factors, like heart or mental diseases, living alone, or access to transportation or air-conditioned environment. In addition, in the case control study on the 1999 Chicago heatwave, Naughton *et al.* [4] found that not leaving home daily was significantly associated with heatwave mortality, but this item was representative of either social habits or dependency for mobility. Our results obtained for a large cohort of dependent elderly subjects also showed that the relative risk for mortality increased with the level of dependency, with a clear dose-effect relationship.

A limitation of our study is the lack of a precise determination of the mortality rate among independent

elderly individuals. In the participating departments, mortality of subjects ≥ 75 years of age in the general population was 0.85 per cent during the same period. Thus mortality among elderly individuals who were not APA beneficiaries was lower than 0.80 per cent, and less than the mortality rate recorded for the least dependent APA beneficiaries assigned GIR group 4. From the data available, it was not possible to estimate more precisely the mortality rate among individuals who were not APA beneficiaries. In addition, it was not possible from our data to assess the risk excess directly related to the dependency level during the heatwaves. The analysis of this interaction between dependency level and heatwave mortality would deserve further investigation, included the analysis of the relationship between mortality and dependency level out from heatwaves. Our study was also limited by the lack of medical information about the APA beneficiaries. Several chronic diseases are associated with dependency in the elderly, particularly diseases known to be risk factors for heatwave-associated mortality like heart failure, respiratory or mental diseases [8]. Similarly, the use of psychotropic drugs and/or diuretics were also found to be risk factors for mortality during heatwaves [5]. In addition, we had no access to information about social or environmental risk factors identified in case control studies, like social

Table 3. Univariate and multivariate analyses of the factors associated with mortality of institutionalised APA beneficiaries during the 2003 heat wave

	Deceased (<i>n</i> = 558)	Alive (<i>n</i> = 14,266)	Mortality rate (per cent)	Univariate <i>P</i>	Adjusted odds- ratios (95% CI) ^a	<i>P</i>
Age (yr, mean ± SD)	86.4 (8.1)	84.5 (9.4)		0.0001	1.015 (1.007–1.022)	0.0001
Sex:						
Men	127 (23)	3,129 (22)	3.9	0.65		
Women	431 (77)	11,122 (78)	3.7			
GIR group						
1	143 (26)	2,326 (17)	5.8	0.0001	2.66 (1.98–3.56)	0.0001
2	265 (48)	5,686 (42)	4.5		2.07 (1.59–2.71)	
3	77 (14)	2,483 (18)	3.0		1.39 (1.00–1.93)	
4	70 (13)	3,179 (23)	2.2		1	
Marital status						
Unmarried, widowed	320 (84)	7,720 (89)	4.0	0.0115		
Married	59 (16)	987 (11)	5.6			
Income (quartiles)						
1st (lowest)	90 (16)	2,684 (20)	3.2	0.09		
2nd	109 (20)	2,496 (19)	4.2			
3rd	145 (26)	3,095 (23)	4.5			
4th	208 (38)	5,219 (39)	3.8			
Department providing APA						
Essonne	122 (22)	3,089 (22)	3.8	0.0001		
Seine et Marne	57 (10)	2,438 (17)	2.3			
Seine Saint-Denis	137 (25)	2,863 (20)	4.6			
Val d'Oise	63 (11)	1,748 (12)	3.5			
Yvelines	179 (32)	4,128 (29)	4.2			
Residential exposure to heatwave related mortality						
Low + intermediate	43 (8)	1,861 (14)	2.3	0.0001	1	0.0001
High	511 (92)	11,814 (86)	4.2		1.86 (1.36–2.55)	

Values are no (%) unless stated otherwise.

^a All the variables with *P* < 10 in the univariate analysis were included in the model.

contacts [5], access to air-conditioning [5, 16], access to transportation [5], or living on the top floor [5]. Therefore, we and others [4, 5, 16] were unable to determine the respective roles of dependency, chronic diseases, drugs or social or environmental factors. However, based on the results of our analysis, we think that dependency might be a direct risk factor for heatwave-associated mortality because unimpaired cognitive functioning, mobility and abilities to drink and bathe might all directly affect appropriate self protective behaviour against heat and/or seeking for assistance. Moreover, the dose-response relationship between the degree of dependency and mortality in both community dwellers and institutionalised subjects is also suggestive of a causal relationship.

We also examined the risk of mortality associated with living in institutions independent of the dependency level during a heatwave. Even if it is generally assumed that institutionalised residents are a high-risk population for heatwaves [16], few data supported this idea. Recently, Heudorf and Meyer [17] also found that living in an institution was associated with excess mortality during the 2003 heatwave in Frankfurt, Germany. Our results confirmed that institutionalised living was associated with a higher risk of mortality even when other factors like age and the dependency level were taken into account. Based

on our analysis, age and the dependency level did not account for all mortality rate differences observed between community dwellers and institutionalised residents, and it is likely that chronic medical conditions also contributed to these differences. However, it should be noted that the adjusted odds ratio for the institutionalised GIR groups were lower than the corresponding values for community dwellers, and this difference might be the consequence of the greater availability of assistance, medical and otherwise, to complete daily living tasks in institutions.

Regardless of the mechanisms responsible for the association between impaired autonomy and heatwave-associated mortality in the elderly, dependency constitutes a simple and strong marker for their vulnerability in coping with heatwaves. This factor might help identify high-risk individuals and guide targeted prevention of heatwave consequences [8, 10, 18]. Pertinently, the higher mortality associated with dependency was found in community dwellers, a population in which detection of individuals at high risk remains a difficult problem.

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