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Chronic medical conditions and their association with crash risk and changes in driving habits: a prospective study of the GAZEL cohort

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ABSTRACT

Objectives To assess crash risk and driving habits associated with chronic medical conditions among drivers entering old age.

Design Prospective cohort study.

Setting French cohort GAZEL.

Participants 12,460 drivers in the analysis of road traffic crash, among whom 11,670 completed the follow-up period (2007-2014). We assessed driving cessation among 11,633 participants over the same period, and mileage and driving avoidance among the 4,973 participants who returned a road safety questionnaire in 2015.

Main outcome measures Yearly occurrence of at least one road crash as a driver; time to driving cessation; mileage; driving avoidance: at night, with bad weather, in heavy traffic, with glare conditions, over long distances.

Results Several potentially risky conditions (angina, myocardial infarction, coronary disease; stroke; nephritic colic, urinary stones; glaucoma) were associated with lower mileage and/or driving avoidance and did not increase crash risk. Neither driving avoidance nor lower mileage was found for other conditions associated with an increased crash risk: hearing difficulties (adjusted OR = 1.19, 95% CI 1.06 to 1.34); joint disorders (1.17, 1.06 to 1.30). Depression, anxiety, stress was associated with an increased crash risk (1.23, 1.01 to 1.49) despite increased driving avoidance. Parkinson's disease was associated with driving cessation (adjusted HR = 32.61, 14.21 to 65.17).

Conclusions Depending on their condition, and probably on the associated risk perception, drivers entering old age report diverse driving habits. For example, hearing difficulties is a frequent condition, rarely considered a threat to road safety, and nonetheless associated with an increased crash risk.

INTRODUCTION

The proportion of people over the age of 75 is expected to almost double by 2050 in high-income countries because of the transformation of demography resulting from the Baby Boom Generation, increased longevity and declining birth rates.[1] As a result, and also because older women are now mainly driving licence holders, the number of elderly drivers on the roads is increasing. Road safety has improved in the European Union (and most high-income countries) in recent decades, but the share of injured and killed older drivers is on the rise.[2]. More affected by the increased enforcement of traffic rules, particularly the speed limit, in the EU policy orientations, the decrease in mortality has been greater among young drivers. The decline in perceptual, motor and cognitive abilities with age may also explain the greater contribution of older drivers to road safety statistics. Driving is indeed a complex task that involves cognition, sensory function, and physical function/health condition.[3] Safe-driving thus requires older drivers to adapt their behaviour and driving habits according to their abilities. It is now well documented that most older adults adapt their driving behaviour when faced with impaired abilities,[4–8] in particular driving abilities.[9,10] However, older drivers only self-regulate to an extent that does not negatively interfere with their lifestyle.[9] The key question may therefore be whether these adaptations are sufficient to counterbalance a potential increased risk.[11]

The second edition to the Monash University report on the influence of medical conditions on crash involvement of motor vehicle drivers [12] listed the following conditions found to be associated with various levels of risk: alcohol abuse and dependence, dementia, epilepsy, multiple sclerosis, psychiatric disorders, schizophrenia, sleep apnea, and cataract. Moreover, a large database linkage study conducted in Quebec on 5,187,049 drivers showed that crash risk increases slightly but significantly with the number of conditions.[13] In some countries, drivers with certain medical conditions have their licences revoked. Whilst this may be sensible for some conditions, any decision concerning driving cessation must take into account its impact on lifestyle, independence, quality of life and mental health.[14] Specific licence restrictions [15] and education programs [16] are promising alternatives to reduce crash risk while still allowing for some degree of autonomy. Anyhow, whatever measures are available, it is important to identify the medical driving disabilities that are not regulated to compensate for the risk.

The aim of this study conducted among volunteers of the French GAZEL cohort was to assess driving cessation, mileage and avoidance, and crash risk for the chronic medical conditions reported by drivers aged 61 to 75 years at the end of the follow-up period.

METHODS

Study population

The GAZEL cohort is a multi-purpose research platform. The participants were employees of Electricité de France–Gaz de France who volunteered to participate in a research cohort.[17]. This cohort was established in 1989 and originally included 20,625 subjects, men aged 40–50 years (n=15,011) and women aged 35–50 years (n=5,614) at baseline. Since 1989, this cohort has been followed up by means of yearly self-administered questionnaires

and data collection from the company's human resources and medical departments. The study protocol was approved by the French authority for data confidentiality (Commission Nationale Informatique et Libertés).

Study design

The study consisted in three separate analyses: (i) a longitudinal analysis on the associations of self-reported chronic conditions with road traffic crash over the 2007-2014 period, (ii) a longitudinal analysis on the associations of self-reported chronic conditions with driving cessation over the 2007-2014 period, (iii) an analysis of the association of self-reported chronic conditions with mileage and driving avoidance in 2015.

Sample selection (Figure S1)

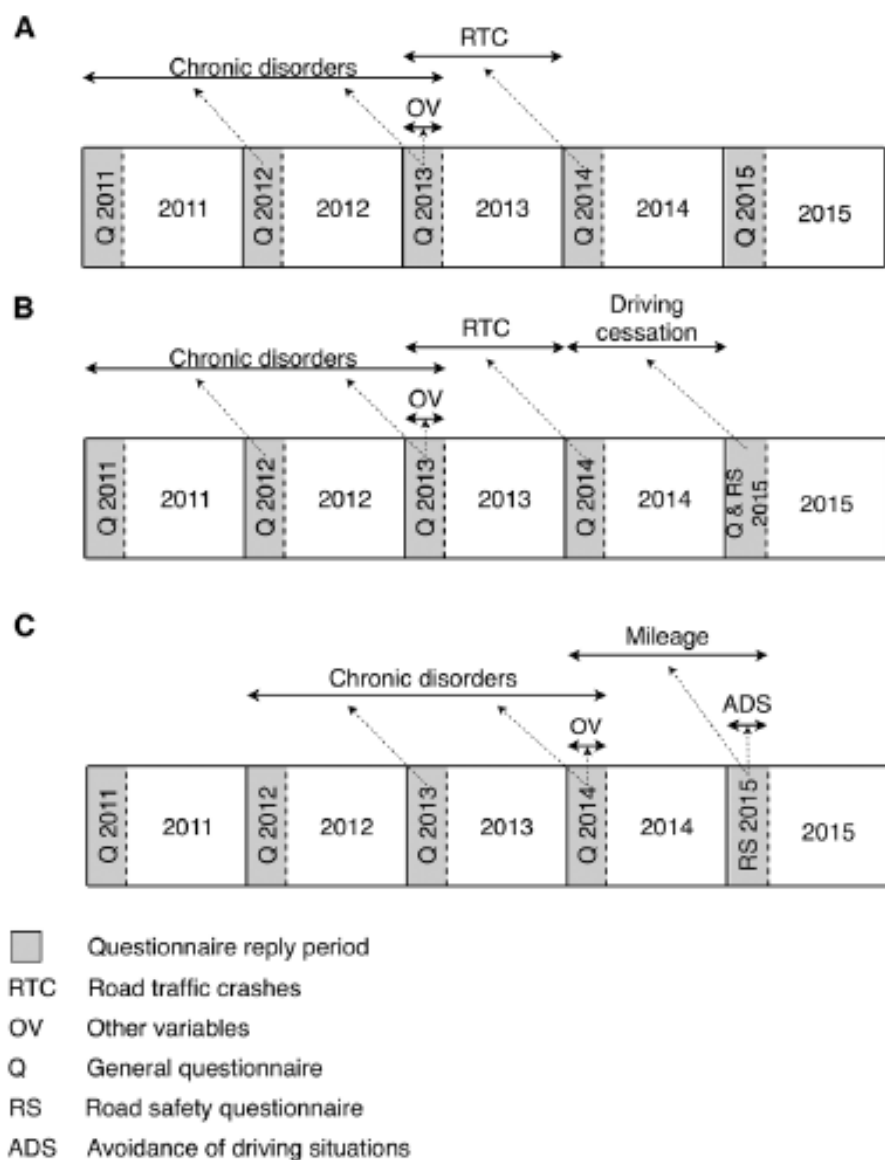


Figure 1 Summary of the data collection process: (A) analysis of road traffic crash (occurrence reported in 2014, eg); (B) analysis of driving cessation in 2014; (C) analysis of self-regulation.

(i) Participants included in the analysis of road traffic crash were drivers who held a driving licence, and who did not stop driving before 2007 or on an unknown date. (ii) Participants

included in the analysis of driving cessation were subjects of the road traffic crash analysis sample with non-missing driving cessation status in 2015. (iii) Participants included in the analysis of mileage and driving avoidance were subjects of the road traffic crash analysis sample who returned the road safety questionnaire in 2015.

Data

Chronic conditions

The part of the annual questionnaire related to medical conditions includes 58 pre-specified items. Every year, participants are invited to indicate which medical condition(s) they have been suffering from during the twelve previous months. The reporting rates had been previously evaluated item by item.[18] Participants reported their hearing difficulties by means of a yes/no question: “do you have hearing difficulties?”, which changed to: “do you have hearing difficulties, even with hearing aids?” from 2014 onwards. In the analysis, a chronic disease was defined as a medical condition declared to be present during at least two consecutive years.

For statistical power reasons, medical conditions were grouped in clinically homogenous categories: 1) angina, myocardial infarction, coronary disease; 2) stroke; 3) nephritic colic and urinary stones; 4) glaucoma; 5) hearing difficulties; 6) joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism, rheumatoid polyarthritis; 7) gout and complications; 8) persistent dental and gum problems; 9) depression, or feeling depressed, anxious or stressed; 10) sleep disorders; 11) cataract; 12) Parkinson’s disease; 13) arteritis of the lower limbs, phlebitis, venous circulatory disorders; 14) hypertension; 15) hemorrhoids; 16) diabetes; 17) biliary stones; 18) neck pain, middle or low back pain, sciatica; 19) retinal detachment; 20) migraine.

Potential confounders

The variables considered in all three analyses as potential confounders were: gender, age, family status (single or widowed, living with a partner, separated or divorced), maximum daily alcohol consumption (abstinent; light consumption: 1 to 3 glasses for men and 1 to 2 for women; moderate consumption: 4 glasses for men and 3 to 4 for women; and heavy consumption: 5 glasses or more), and (for the analysis of driving cessation only) occurrence of at least one road traffic crash in the previous year.

Response variable

- (i) The analysis of road traffic crash assessed the occurrence of at least one road traffic crash as a driver, causing personal injury and/or material damage. Participants reported this variable each calendar year of the study period.
- (ii) The analysis of driving cessation assessed the time to driving cessation. Year of driving cessation was reported in both the 2015 road safety questionnaire and the 2015 yearly questionnaire. We used other available driving-related variables to check the consistency of these values and, when in doubt, we assumed the valid value was the latest.
- (iii) The analysis of mileage and driving avoidance compared mileage, and the avoidance of each of five specific driving situations (driving at night, with bad weather, in heavy traffic, with glare conditions, and over long distances). In the 2015 road safety questionnaire, participants reported their mileage and selected each of the driving situations they avoided from a list of 17 (Table S8).

We considered the temporal order so that the values of chronic conditions and confounders antedated the value of the response variable (Figure 1). We included chronic conditions and

confounders as time-dependent variables in the longitudinal analyses of road traffic crash and driving cessation.

Statistical methods

- (i) In the analysis of the risk of road traffic crash, we used the lme4 R package [19] to fit a multivariable mixed effects logistic model,[20] which accounts for correlation between the observations of each subject over time. We reported odds ratio point estimates with 95% confidence intervals.
- (ii) In the analysis of driving cessation, we used the glm function of the stats R package to fit a multivariable discrete-time model,[21] which accounts for the discrete nature of event times and allows for explanatory variables whose values change over time. We reported hazard ratio point estimates with 95% confidence intervals.
- (iii) We fitted a multivariable linear model (lm function of the stats package) to study the association of chronic conditions with mileage, and five multivariable logistic regressions (glm function) to study the association with the avoidance of the five specific driving situations. We reported linear coefficients for the linear model and odds ratio point estimates for the logistic models. We also reported 95% confidence intervals (Table 1).

In order to check consistencies within groups of conditions, we performed the analyses (odds of crash and mileage) for the following separate conditions: angina, myocardial infarction, coronary artery disease, joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism, rheumatoid polyarthritis, arteritis of the lower limbs, phlebitis, and venous circulatory disorders.

All the analyses were performed on the complete observations set and computations were done in R/3.5.1.

RESULTS

Analysis of road traffic crash

Of the 20,625 participants enrolled in the cohort in 1989, 19,123 were solicited in 2007 and 14,321 answered the 2007 questionnaire (Figure S1). After exclusion of people without a driving licence, who had never driven, who stopped driving before the study period and who stopped driving on an unknown date, 12,460 participants were included in 2007, of which 355 men (3.7%) and 774 women (26.8%) were still working on 1 January 2007. 532 participants died during the study period, 137 stopped driving and 121 were excluded from the study. Consequently, 11,670 (93.7%) were observed throughout the 2007-2014 follow-up period. Among them, zero men and 41 women (1.5%) were still working on 31 December 2014. The proportion who reported at least one road traffic crash during the previous year increased during the study period (from 2.8% in 2007 to 3.2% in 2014); 17.8% reported to have been victims of road traffic crash in at least one year of the 8-year follow-up period, 3.8% in at least two years and 0.6% in at least three years. In 2007, 76.8% of the participants were men, the mean age was 62.4 years old (SD=3.4), with ages ranging between 54 and 68 at the beginning of the study period and between 61 and 75 at the end of the study period. Most of them were living with a partner (Table S2).

The most prevalent chronic conditions throughout the whole study period were: neck pain, middle back pain, low back pain and sciatica (33.5%), joint, muscle pain, carpal tunnel

syndrome, arthrosis, rheumatism, rheumatoid polyarthritis (30.9%), hypertension (19.5%), hearing impairment (18.5%) and sleep disorders (10.5%). The prevalence of several medical conditions increased between 2007 and 2014, namely Parkinson's disease (0.1% to 0.4%), cataract (1.0% to 2.5%), diabetes (4.1% to 6.8%), glaucoma (3.0% to 4.5%), gout (0.9% to 1.2%), stroke (0.3% to 0.4%), hypertension (19.5% to 24.9%), hearing impairment (18.5% to 23.6%), biliary stones (0.4% to 0.5%), urinary calculus (0.5% to 0.6%), angina, myocardial infarction, coronary artery disease (1.9% to 2.2%), sleep disorders (10.5% to 11.7%) and joint, muscle pain, carpal tunnel syndrome, arthrosis, rheumatism, rheumatoid polyarthritis (30.9% to 32.5%).

In the multivariable mixed effects logistic model, several diseases were associated with increased odds of crash: hearing impairment (OR=1.19 [1.06-1.34]), joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism or rheumatoid polyarthritis (OR=1.17 [1.06-1.30]), and depression, feeling depressed, anxious or stressed (OR=1.23 [1.01-1.49]) (Table 1).

Analysis of driving cessation

People who did not report their driving cessation status in 2015, such as people who died during the follow-up period, were excluded from this part of the study, composed of 11,633 participants in 2007. Among them, 1.2% stopped driving during the study period; 1,984 participants had incomplete data in 2007 and 2,181 in 2014. Parkinson's disease was the only condition associated with increased driving cessation (HR=32.61 [14.21-65.17]).

Analysis of mileage and driving avoidance

A total of 4,973 participants were included in the assessment of mileage and avoided driving situations in 2015, after exclusion of people who did not complete the period 2007-2014 or who did not return the road safety specific questionnaire. There were 777 participants with incomplete data in the sample of the mileage analysis, and 807 in the sample of the avoided driving situations analysis. The mean mileage was 13,094 kilometers (SD=8,080). A proportion of 39.1% of the participants reported to avoid driving at night, 28.8% with bad weather, 21.2% in heavy traffic, 14.0% with glare conditions, and 12.0% over long distances.

Among conditions found in the previous steps not to be associated with increased odds of crash, angina, myocardial infarction, coronary artery disease was associated with the avoidance of driving with heavy traffic (Table 2, Figure 2). Stroke was associated with mileage reduction, and with avoidance of driving with bad weather and long distances. Participants with nephritic colic and urinary stones were more likely to avoid driving at night and had decreased odds of road traffic crash. Glaucoma was associated with mileage reduction.

Among conditions found to be associated with increased odds of crash, participants with hearing difficulties reported neither decreased mileage nor avoidance of any driving situation, whereas gout, and joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism or rheumatoid polyarthritis, were associated with increased mileage. Gout, and dental and gum problems were associated with increased odds of crash, though not significantly ($0.20 \geq P > 0.05$). Other conditions were associated with increased odds of crash, in spite of reduced mileage and/or avoidance of driving situations. This was the case for participants feeling depressed, anxious or stressed, who were more likely to avoid driving

at night, with bad weather, in heavy traffic and over long distances in 2015. Sleep disorders and cataract increased odds of crash, though not significantly ($0.20 \geq P > 0.05$). Participants with sleep disorders were more likely to avoid driving at night, with glare conditions and over long distances, whereas cataract was associated with mileage reduction.

Sensitivity analysis

Joint or muscle pain showed increased odds of crash and no mileage reduction, while arthrosis and rheumatism were associated with increased mileage but did not impact the crash risk. Carpal tunnel syndrome showed a non-significant, but potentially meaningful association with increased odds of crash (Table S5).

Table 1. Analysis of road traffic crash 2007-2014. Multivariable mixed effects logistic regression.

	2007	2014	
	N	N	
	12,460	11,670	
	%	%	Odds ratio
			(95% CI)
Gender (ref: women)	23.2	23.1	-
Men	76.8	76.9	1.56 (1.33-1.82) ^{***}
Age at baseline (centered at 60 years old)	-	-	0.99 (0.97-1.01)
Family status (ref: living with a partner)	83.0	78.8	-
Divorced or separated	7.8	8.1	1.45 (1.21-1.73) ^{***}
Living alone or widow(-er)	5.6	7.3	1.38 (1.13-1.70) ^{**}
Maximum daily alcohol consumption (ref: abstinent)	13.7	15.2	-
Light drinkers	46.4	48.8	1.07 (0.92-1.24)
Moderate drinkers	17.7	15.6	1.16 (0.98-1.37)
Heavy drinkers	17.5	14.0	1.20 (1.01-1.43) [*]
Chronic conditions (ref: absence of the particular disorder)	-	-	-
Angina, myocardial infarction, coronary artery disease	2.0	2.2	1.00 (0.73-1.37)
Stroke	0.3	0.4	1.10 (0.52-2.34)
Nephritic colic and urinary stones	0.5	0.6	0.42 (0.18-0.99) [*]
Glaucoma	3.0	4.5	0.93 (0.72-1.22)
Hearing difficulties	18.3	23.5	1.19 (1.06-1.34) ^{**}
Joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism, rheumatoid polyarthritis	30.5	32.4	1.17 (1.06-1.30) ^{**}
Gout and complications	0.9	1.1	1.46 (0.99-2.17)
Persistent dental and gum problems	2.1	1.6	1.23 (0.92-1.66)
Depression; feeling depressed, anxious or stressed	6.2	4.7	1.23 (1.01-1.49) [*]
Sleep disorders	10.5	11.7	1.14 (0.98-1.32)
Cataract	1.0	2.5	1.27 (0.91-1.76)
Parkinson's disease	0.1	0.4	1.57 (0.62-4.02)
Arteritis of the lower limbs, phlebitis, venous circulatory disorders	4.4	3.9	0.96 (0.75-1.22)
High blood pressure	19.6	24.8	1.02 (0.91-1.15)
Hemorrhoids	8.3	6.6	1.10 (0.93-1.30)
Diabetes	4.4	6.8	1.07 (0.87-1.32)
Biliary stones	0.4	0.5	0.75 (0.36-1.57)
Neck pain, middle back pain, low back pain, sciatica	33.1	31.8	0.96 (0.86-1.07)
Retinal detachment	0.1	0.1	0.99 (0.37-2.70)
Migraine	6.3	3.9	1.13 (0.92-1.40)

*: P <= 0.05, **: P <= 0.01, ***: P <= 0.001

Table 2. Point estimates of the multivariable models.

	Mileage ^a	Avoided driving situations ^b					Driving	Road
		Night	Bad weather	Heavy traffic	Glare	Long distance	cessation ^c	Traffic Crash ^d
Gender (ref: women)								
Men	9 070*	0.25*	0.87	1.39*	0.46*	0.36*	0.31*	1.56*
Age at baseline (years)	-274 ^{e*}	1.06 ^{e*}	1.06 ^{e*}	1.01 ^e	1.05 ^{e*}	1.06 ^{e*}	1.12*	0.99 ^f
Family status (ref: living with a partner)								
Divorced or separated	971*	1.02	1.21	0.98	0.89	1.12	1.66*	1.45*
Living alone or widow(-er)	724	0.91	1.29	0.89	0.89	1.30	1.21	1.38*
Maximum daily alcohol consumption (ref: abstinent)								
Light drinkers	-67	1.19	1.02	0.94	0.91	1.02	0.65*	1.07
Moderate drinkers	634	1.07	0.90	1.06	0.77	0.81	0.58	1.16
Heavy drinkers	876*	1.25	0.96	0.84	1.35	0.99	0.31*	1.20*
(At least one) road traffic crash (ref: no)	-	-	-	-	-	-	1.31	-
Chronic conditions (ref: absence of the particular disorder)								
Angina, myocardial infarction, coronary artery disease	769	0.93	0.99	1.70*	0.72	1.03	0.58	1.00
Stroke	-5 737*	1.57	3.06*	0.22	1.45	3.46*	3.32	1.10
Nephritic colic and urinary stones	811	2.63*	0.92	0.56	1.36	0.39	- ^g	0.42*
Glaucoma	-1 434*	1.25	1.05	1.21	1.34	1.08	1.60	0.93
Hearing difficulties	212	1.13	1.02	1.01	1.05	0.95	1.08	1.19*
Joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism, rheumatoid polyarthritis	538*	0.96	1.01	0.99	1.10	0.99	1.11	1.17*
Gout and complications	2 425*	1.01	1.04	1.31	0.97	0.52	0.91	1.46
Persistent dental and gum problems	57	1.04	0.86	0.78	1.40	1.21	0.78	1.23
Depression; feeling depressed, anxious or stressed	-415	1.56*	1.41*	1.45*	1.21	1.80*	1.39	1.23*
Sleep disorders	-309	1.27*	1.04	1.07	1.40*	1.33*	1.14	1.14
Cataract	-2 517*	1.26	0.91	0.82	1.26	0.94	1.79	1.27
Parkinson's disease	-3 758	1.59	1.61	1.70	1.70	1.32	32.61*	1.57
Arteritis of the lower limbs, phlebitis, venous circulatory disorders	157	0.70	0.96	1.05	0.87	1.21	1.35	0.96
High blood pressure	278	1.01	0.98	1.08	1.09	0.92	1.10	1.02
Hemorrhoids	255	1.13	1.05	1.14	0.98	1.03	1.16	1.10
Diabetes	-426	1.17	1.00	1.02	1.17	1.17	1.68	1.07
Biliary stones	-1 453	0.92	0.29	1.02	1.85	0.75	- ^g	0.75
Neck pain, middle back pain, low back pain, sciatica	-304	1.10	0.89	0.97	1.19	1.08	0.92	0.96
Retinal detachment	1 359	2.54	1.15	0.95	2.47	0.72	- ^g	0.99
Migraine	236	1.03	1.00	0.88	1.02	1.32	1.23	1.13

a) Linear regression coefficients, in kilometers (2015); b) odds ratios from logistic regression (2015); c) hazard ratios from a discrete-time model (2007-2014); d) odds ratios from mixed effects logistic regression (2007-2014); e) age centered at 70 years old; f) age centered at 60 years old; g) few cases of driving cessation among participants with these disorders lead to wide confidence intervals that include zero; *) p <= 0.05.



Figure 2 Effects of chronic disorders on mileage, avoidance of specific driving situations (multivariable cross-sectional analyses, 2015), driving cessation and road traffic crash (multivariable longitudinal analyses, 2007–2014). The chronic disorders shown were associated ($p \leq 0.05$) with the avoidance of at least one specific driving situation, or with road traffic crash ($p \leq 0.20$).

DISCUSSION

To our knowledge, this study is the first to assess the impact of chronic conditions, jointly on driving habits and the risk of road traffic crashes. Eleven conditions were found to be of interest, with three distinct patterns.

The first pattern includes conditions associated with lower mileage (stroke and glaucoma) and/or the avoidance of specific driving situations (cardiovascular conditions, stroke, nephritic colic and urinary stones), and no crash risk.

A second pattern could be distinguished, probably the most interesting in terms of public health, with conditions associated with increased odds of crash and not associated with mileage reduction or driving avoidance: hearing problems, joint disorders, gout, and dental and gum problems. We observed a higher mileage for gout, possibly related to walking

difficulties and arguably explaining the increased odds of crash.

Finally, people who reported depression, anxiety or stress, exhibited a third pattern as they reported more avoidance strategies but still had increased odds of crash. Participants with sleep disorders and cataract may also fit into this group although their associations with the odds of crash were not significant. Parkinson's disease represents a particular case, essentially defined by massive driving cessation.

We previously conducted, among volunteers of the same cohort, an analysis of road traffic crashes over the 1989-2000 period and found an association with pain and pain treatment.[22] In this new study period, participants were on average 17 years older and were likely to have changed their driving habits, for example because of retirement.

Our results seem to support the hypothesis that the potential crash risk carried by cardiovascular conditions is mitigated by self-regulation. However, to assume self-regulation, changes must occur in response to an awareness of functional declines or feelings of discomfort or lack of safety, [23] which we cannot confirm in our study. Stroke had relatively large effects on mileage reduction, and the avoidance of driving over long distances and in adverse weather conditions. Nevertheless, several studies showed that post-stroke drivers have difficulties in self-evaluating their fitness to drive.[24,25] Angina, myocardial infarction or coronary disease were associated with the avoidance of driving in heavy traffic, a potentially stressful situation. Consistently with our results, associations with driving self-regulation have been already reported for cataract [26,27] and glaucoma.[28] People suffering from nephritic colic and urinary stones reported to avoid driving at night, a time when the symptoms of kidney stone emergencies typically begin.[29] Interestingly, our previous analysis found a similar association for treated urinary stone and the risk of road crash among men.[22]

The second pattern is more problematic as it includes conditions for which we found increased risks of crash and no self-regulation. Associations between rheumatoid arthritis and driving difficulties have been reported elsewhere.[30] Our result raises the hypothesis that the crash risk among people who suffer from gout, with potential walking impairment, may be related to an increased exposure to driving. A recent study conducted among older adults found that drivers with hearing impairment did not reduce their mileage [31] while this condition may hamper driving performance in the presence of distracters.[32]

People with depression, anxiety or stress suffer from increased odds of crash, although they were more likely to avoid four out of the five driving situations studied. Depression was previously found to be associated with slower reaction time in a driving simulator [33] and with lower scores in attention abilities.[34] It cannot be excluded that some psychotropic or analgesic drugs prescribed in the context of these conditions increased the risk of crash.[35,36] The observed decrease in the prevalence of these conditions between 2007 and 2014 (Table 1) is compatible with a previous study on this cohort, which showed an association between retirement and a reduction in fatigue and depressive symptoms.[37] Parkinson's disease has been typically observed as a trigger to driving cessation,[38] in accordance with our results.

The GAZEL cohort is characterized by a low loss to follow-up and active participation is high: in 2013, only 555 (2.6%) either never answered the annual questionnaire after 1989 or formally decided to stop their participation; 135 (0.6%) were lost to follow-up. [39]

One weakness of the study is the self-reported nature of health questions and the lack of health examination. Even if data gathered over the 30 years of follow-up showed that those

reports are valuable and accurate proxy for most chronic conditions, it is not the case for all of them, in particular cognitive conditions, which were therefore not included. The proportions of missing values in the reporting of chronic conditions were found to increase from 2007 to 2014 (Online supplementary table 3).

Because the road safety questionnaires were sent in 2007 and 2015, the number of kilometers driven was only available for those two years. Consequently, the results may be confounded by changes in annual mileage between 2007 and 2015.

In summary, our data suggest that drivers entering old ages use self-regulation strategies likely to mitigate a potentially increased risk of road traffic crash. This regulation depends however on the condition. Therefore, specific focus should be initiated or strengthened to question risk perception and level of knowledge, [40] and to improve the level of awareness of conditions such as hearing loss, which is rarely cited as a threat to road safety, and those that reduce walking mobility, which are likely to increase the vulnerability toward road injuries.

SUMMARY BOX

What is already known on this topic

- Overall health status and several medical conditions have been found to be associated with the risk of road traffic crash in the general population of drivers.
- Most older adults adapt their driving behaviour when faced with impaired driving ability.
- Conditions with no or inappropriate compensatory behaviours need to be identified.

What this study adds

- Our data suggest that drivers who enter old age and suffer from some medical conditions use condition-specific strategies of self-regulation to mitigate the potentially increased risk of road traffic crash.
- For people with a number of risk conditions, including hearing loss and diseases that reduce walking mobility, there is no self-regulation, suggesting the need to initiate or strengthen specific focuses and to improve the level of awareness.

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SUPPLEMENTARY TABLES

Table 1. Summary of the methods.

Study population	Participants of the French GAZEL cohort (20,625 at baseline, 19,123 solicited in 2007, 14,321 respondents in 2007)			
Analysis	Road traffic crash	Driving cessation	Mileage and avoided situations	
Sample (Figure S1)	Active drivers who held a driving licence, and who did not stop driving before 2007 or on an unknown date (N=12,460 in 2007).	Subjects of the road traffic crash analysis sample with non-missing driving cessation status in 2015 (N=11,633 in 2007).	Subjects of the road traffic crash analysis sample who returned the road safety questionnaire in 2015 (N=4,973 in 2015).	
Period	2007-2014	2007-2014	2015	
Data				
<i>Chronic conditions</i>	Twenty self-reported chronic conditions, or groups of conditions.			
<i>Potential confounders</i>	Gender, age, family status and maximum daily alcohol consumption.	Gender, age, family status, maximum daily alcohol consumption and road traffic crash.	Gender, age, family status and maximum daily alcohol consumption.	
<i>Response variable</i>	Yearly occurrence of at least one road traffic crash.	Year of driving cessation.	Mileage, in kilometers.	Avoidance of a specific driving situation: night, bad weather, heavy traffic, glare conditions, and long distances.
Statistical model	Mixed effects logistic regression.	Discrete-time model.	Linear regression	Five separate logistic regressions (one for each specific situation).

Table 2. Evolution of the number of participants who reported at least one road traffic crash (sample for the analysis risk of road traffic crash)

	Participants (%)	Participants reporting at least one crash (%)	Missing values in accident reporting (%)
2007	12 460 (100.0)	352 (2.8)	347 (2.8)
2008	12 397 (99.5)	373 (3.0)	746 (6.0)
2009	12 310 (98.8)	349 (2.8)	709 (5.8)
2010	12 189 (97.8)	320 (2.6)	675 (5.5)
2011	12 072 (96.9)	317 (2.6)	731 (6.1)
2012	11 953 (95.9)	336 (2.8)	890 (7.4)
2013	11 806 (94.8)	360 (3.0)	879 (7.4)
2014	11 670 (93.7)	377 (3.2)	976 (8.4)

Table 3. Characteristics of participants in 2007 and 2014 (sample for the analysis of the risk of road traffic crash)

	2007		2014	
	N (%)	Missing (%)	N (%)	Missing (%)
Gender		0 (0.0)		0 (0.0)
Women	2 891 (23.2)		2 695 (23.1)	
Men	9 569 (76.8)		8 975 (76.9)	
Family status		449 (3.6)		672 (5.8)
Living with a partner	10 338 (83.0)		9 199 (78.8)	
Divorced or separated	978 (7.8)		944 (8.1)	
Living alone or widow(-er)	695 (5.6)		855 (7.3)	
Maximum daily alcohol consumption		599 (4.8)		743 (6.4)
Abstinent	1 701 (13.7)		1 778 (15.2)	
Light drinkers	5 784 (46.4)		5 696 (48.8)	
Moderate drinkers	2 200 (17.7)		1 820 (15.6)	
Heavy drinkers	2 176 (17.5)		1 633 (14.0)	
Chronic conditions				
Angina, myocardial infarction, coronary artery disease	252 (2.0)	188 (1.5)	254 (2.2)	212 (1.8)
Stroke	38 (0.3)	171 (1.4)	50 (0.4)	200 (1.7)
Nephritic colic and urinary stones	68 (0.5)	174 (1.4)	73 (0.6)	196 (1.7)
Glaucoma	380 (3.0)	191 (1.5)	528 (4.5)	218 (1.9)
Hearing difficulties	2 286 (18.3)	1 815 (14.6)	2 738 (23.5)	1 713 (14.7)
Joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism, rheumatoid polyarthritis	3 803 (30.5)	470 (3.8)	3 776 (32.4)	440 (3.8)
Gout and complications	115 (0.9)	175 (1.4)	134 (1.1)	196 (1.7)
Persistent dental and gum problems	262 (2.1)	218 (1.7)	191 (1.6)	227 (1.9)
Depression; feeling depressed, anxious or stressed	771 (6.2)	283 (2.3)	551 (4.7)	263 (2.3)
Sleep disorders	1 312 (10.5)	321 (2.6)	1 360 (11.7)	307 (2.6)
Cataract	122 (1.0)	181 (1.5)	288 (2.5)	220 (1.9)
Parkinson's disease	11 (0.1)	170 (1.4)	42 (0.4)	194 (1.7)
Arteritis of the lower limbs, phlebitis, venous circulatory disorders	545 (4.4)	222 (1.8)	452 (3.9)	238 (2.0)
High blood pressure	2 448 (19.6)	300 (2.4)	2 894 (24.8)	362 (3.1)
Hemorrhoids	1 035 (8.3)	244 (2.0)	770 (6.6)	235 (2.0)

	2007		2014	
	N (%)	Missing (%)	N (%)	Missing (%)
Diabetes	544 (4.4)	207 (1.7)	790 (6.8)	237 (2.0)
Biliary stones	51 (0.4)	173 (1.4)	59 (0.5)	194 (1.7)
Neck pain, middle back pain, low back pain, sciatica	4 119 (33.1)	481 (3.9)	3 708 (31.8)	442 (3.8)
Retinal detachment	18 (0.1)	169 (1.4)	16 (0.1)	191 (1.6)
Migraine	781 (6.3)	245 (2.0)	451 (3.9)	223 (1.9)

Table 4. Analysis of road traffic crash 2007-2014. Multivariable mixed effects model.

	2007 N 12,460 %	2014 N 11,670 %	Odds ratio (95% CI)	p-value
Intercept	-	-	0.01 (0.01-0.01)	<0.001
Gender (ref: women)	23.2	23.1		
Men	76.8	76.9	1.56 (1.33-1.82)	<0.001
Age at baseline (centered at 60 years old)	-	-	0.99 (0.97-1.01)	0.247
Family status (ref: living with a partner)	83.0	78.8		
Divorced or separated	7.8	8.1	1.45 (1.21-1.73)	<0.001
Living alone or widow(-er)	5.6	7.3	1.38 (1.13-1.70)	0.002
Maximum daily alcohol consumption (ref: abstinent)	13.7	15.2		
Light drinkers	46.4	48.8	1.07 (0.92-1.24)	0.365
Moderate drinkers	17.7	15.6	1.16 (0.98-1.37)	0.094
Heavy drinkers	17.5	14.0	1.20 (1.01-1.43)	0.040
Chronic conditions (ref: absence of the particular disorder)	-	-		
Angina, myocardial infarction, coronary artery disease	2.0	2.2	1.00 (0.73-1.37)	0.999
Stroke	0.3	0.4	1.10 (0.52-2.34)	0.810
Nephritic colic and urinary stones	0.5	0.6	0.42 (0.18-0.99)	0.047
Glaucoma	3.0	4.5	0.93 (0.72-1.22)	0.622
Hearing difficulties	18.3	23.5	1.19 (1.06-1.34)	0.003
Joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism, rheumatoid polyarthritis	30.5	32.4	1.17 (1.06-1.30)	0.003
Gout and complications	0.9	1.1	1.46 (0.99-2.17)	0.058
Persistent dental and gum problems	2.1	1.6	1.23 (0.92-1.66)	0.166
Depression; feeling depressed, anxious or stressed	6.2	4.7	1.23 (1.01-1.49)	0.042
Sleep disorders	10.5	11.7	1.14 (0.98-1.32)	0.091
Cataract	1.0	2.5	1.27 (0.91-1.76)	0.162
Parkinson's disease	0.1	0.4	1.57 (0.62-4.02)	0.343
Arteritis of the lower limbs, phlebitis, venous circulatory disorders	4.4	3.9	0.96 (0.75-1.22)	0.715
High blood pressure	19.6	24.8	1.02 (0.91-1.15)	0.719
Hemorrhoids	8.3	6.6	1.10 (0.93-1.30)	0.271
Diabetes	4.4	6.8	1.07 (0.87-1.32)	0.522
Biliary stones	0.4	0.5	0.75 (0.36-1.57)	0.446

	2007	2014		
	N	N		
	12,460	11,670		
	%	%	Odds ratio	p-value
			(95% CI)	
Neck pain, middle back pain, low back pain, sciatica	33.1	31.8	0.96 (0.86-1.07)	0.460
Retinal detachment	0.1	0.1	0.99 (0.37-2.70)	0.988
Migraine	6.3	3.9	1.13 (0.92-1.40)	0.244
Year (ref: 2007)	-	-		
2008	-	-	1.12 (0.95-1.33)	0.162
2009	-	-	1.05 (0.89-1.24)	0.585
2010	-	-	0.95 (0.80-1.13)	0.576
2011	-	-	0.94 (0.79-1.12)	0.492
2012	-	-	1.03 (0.87-1.23)	0.698
2013	-	-	1.17 (0.98-1.38)	0.074
2014	-	-	1.20 (1.01-1.42)	0.036

Table 5. Analysis of road traffic crash 2007-2014. Multivariable mixed effects model, sensitivity analysis. We broke down the groups formed by angina, myocardial infarction and coronary artery disease, arteritis of the lower limbs, phlebitis, venous circulatory disorders, and joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism and rheumatoid polyarthritis.

	2007	2014		
	N	N		
	12,460	11,670		
	%	%	Odds ratio (95% CI)	p-value
Intercept	-	-	0.01 (0.01-0.01)	<0.001
Gender (ref: women)	23.2	23.1		
Men	76.8	76.9	1.55 (1.32-1.82)	<0.001
Age at baseline (centered at 60 years old)	-	-	0.99 (0.97-1.01)	0.310
Family status (ref: living with a partner)	83.0	78.8		
Divorced or separated	7.8	8.1	1.45 (1.21-1.74)	<0.001
Living alone or widow(-er)	5.6	7.3	1.39 (1.13-1.70)	0.002
Maximum daily alcohol consumption (ref: abstinent)	13.7	15.2		
Light drinkers	46.4	48.8	1.07 (0.92-1.24)	0.365
Moderate drinkers	17.7	15.6	1.16 (0.98-1.37)	0.091
Heavy drinkers	17.5	14.0	1.20 (1.01-1.44)	0.039
Chronic conditions (ref: absence of the particular disorder)	-	-		
Angina, coronary artery disease	1.0	1.2	1.05 (0.68-1.60)	0.830
Myocardial infarction	1.0	1.0	0.94 (0.60-1.48)	0.798
Stroke	0.3	0.4	1.10 (0.52-2.35)	0.799
Nephritic colic and urinary stones	0.5	0.6	0.42 (0.18-0.99)	0.047
Glaucoma	3.0	4.5	0.93 (0.71-1.22)	0.619
Hearing difficulties	18.3	23.5	1.19 (1.06-1.34)	0.003
Joint or muscle pain	21.9	23.2	1.15 (1.03-1.29)	0.012
Carpal tunnel syndrome	2.0	1.5	1.33 (0.97-1.82)	0.075
Arthrosis, rheumatism	14.3	16.9	0.98 (0.86-1.13)	0.815
Rheumatoid polyarthritis	0.7	0.7	1.35 (0.79-2.33)	0.274
Gout and complications	0.9	1.1	1.46 (0.98-2.17)	0.060
Persistent dental and gum problems	2.1	1.6	1.22 (0.91-1.65)	0.180
Depression; feeling depressed, anxious or stressed	6.2	4.7	1.22 (1.00-1.49)	0.045
Sleep disorders	10.5	11.7	1.14 (0.98-1.32)	0.087
Cataract	1.0	2.5	1.27 (0.91-1.77)	0.161

	2007	2014		
	N	N		
	12,460	11,670		
	%	%	Odds ratio (95% CI)	p-value
Parkinson's disease	0.1	0.4	1.55 (0.61-3.97)	0.360
Arteritis of the lower limbs	0.7	0.8	0.65 (0.35-1.21)	0.174
Phlebitis	0.2	0.2	1.10 (0.43-2.82)	0.837
Venous circulatory disorders	3.7	2.9	0.99 (0.75-1.31)	0.959
High blood pressure	19.6	24.8	1.03 (0.91-1.16)	0.665
Hemorrhoids	8.3	6.6	1.10 (0.93-1.30)	0.275
Diabetes	4.4	6.8	1.07 (0.87-1.33)	0.510
Biliary stones	0.4	0.5	0.75 (0.36-1.57)	0.444
Neck pain, middle back pain, low back pain, sciatica	33.1	31.8	0.97 (0.87-1.07)	0.531
Retinal detachment	0.1	0.1	1.00 (0.37-2.72)	0.993
Migraine	6.3	3.9	1.14 (0.92-1.41)	0.236
Year (ref: 2007)	-	-		
2008	-	-	1.12 (0.95-1.32)	0.165
2009	-	-	1.05 (0.89-1.24)	0.584
2010	-	-	0.95 (0.80-1.13)	0.596
2011	-	-	0.94 (0.79-1.12)	0.507
2012	-	-	1.04 (0.87-1.23)	0.673
2013	-	-	1.17 (0.99-1.38)	0.071
2014	-	-	1.20 (1.01-1.42)	0.034

Table 6. Characteristics of participants in 2007 and 2014 (sample for the analysis of driving cessation)

	2007		2014	
	N (%)	Missing (%)	N (%)	Missing (%)
Gender		0 (0.0)		0 (0.0)
Women	2 733 (23.5)		2 667 (23.2)	
Men	8 900 (76.5)		8 829 (76.8)	
Family status		382 (3.3)		621 (5.4)
Living with a partner	9 705 (83.4)		9 097 (79.1)	
Divorced or separated	909 (7.8)		934 (8.1)	
Living alone or widow(-er)	637 (5.5)		844 (7.3)	
Maximum daily alcohol consumption		520 (4.5)		693 (6.0)
Abstinent	1 578 (13.6)		1 749 (15.2)	
Light drinkers	5 456 (46.9)		5 635 (49.0)	
Moderate drinkers	2 052 (17.6)		1 806 (15.7)	
Heavy drinkers	2 027 (17.4)		1 613 (14.0)	
(At least one) road traffic crash	333 (2.9)	310 (2.7)	374 (3.3)	887 (7.7)
Chronic conditions				
Angina, myocardial infarction, coronary artery disease	222 (1.9)	149 (1.3)	249 (2.2)	182 (1.6)
Stroke	34 (0.3)	135 (1.2)	50 (0.4)	169 (1.5)
Nephritic colic and urinary stones	63 (0.5)	139 (1.2)	73 (0.6)	166 (1.4)
Glaucoma	347 (3.0)	154 (1.3)	521 (4.5)	188 (1.6)
Hearing difficulties	2 153 (18.5)	1 636 (14.1)	2 711 (23.6)	1 648 (14.3)
Joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism, rheumatoid polyarthritis	3 595 (30.9)	398 (3.4)	3 733 (32.5)	401 (3.5)
Gout and complications	110 (0.9)	141 (1.2)	132 (1.2)	166 (1.4)
Persistent dental and gum problems	243 (2.1)	176 (1.5)	189 (1.6)	197 (1.7)
Depression; feeling depressed, anxious or stressed	716 (6.2)	233 (0.2)	542 (4.7)	229 (2.0)
Sleep disorders	1 226 (10.5)	262 (2.3)	1 344 (11.7)	273 (2.4)
Cataract	114 (1.0)	143 (1.2)	284 (2.5)	188 (1.6)
Parkinson's disease	10 (0.1)	134 (1.2)	41 (0.4)	163 (1.4)
Arteritis of the lower limbs, phlebitis, venous circulatory disorders	489 (4.2)	177 (1.5)	446 (3.9)	206 (1.8)
High blood pressure	2 263 (19.5)	243 (2.1)	2 865 (24.9)	325 (2.8)

	2007		2014	
	N (%)	Missing (%)	N (%)	Missing (%)
Hemorrhoids	981 (8.4)	202 (1.7)	761 (6.6)	203 (1.8)
Diabetes	482 (4.1)	160 (1.4)	780 (6.8)	202 (1.8)
Biliary stones	48 (0.4)	139 (1.2)	59 (0.5)	164 (1.4)
Neck pain, middle back pain, low back pain, sciatica	3 901 (33.5)	413 (3.6)	3 668 (31.9)	405 (3.5)
Retinal detachment	17 (0.1)	135 (1.2)	16 (0.1)	160 (1.4)
Migraine	735 (6.3)	202 (1.7)	446 (3.9)	193 (1.7)

Table 7. Analysis of driving cessation 2007-2014. Multivariable discrete-time model, complementary log-log function.

	2007 N 11,633 %	2014 N 11,496 %	Hazard ratio (95% CI)	p-value
Intercept	-	-	0.00 (0.00-0.01)	<0.001
Gender (ref: women)	23.5	23.2		
Men	76.5	76.8	0.31 (0.21-0.47)	<0.001
Age at baseline (centered at 60 years old)	-	-	1.12 (1.07-1.18)	<0.001
Family status (ref: living with a partner)	83.4	79.1		
Divorced or separated	7.8	8.1	1.66 (0.99-2.64)	0.042
Living alone or widow(-er)	5.5	7.3	1.21 (0.67-2.04)	0.497
Maximum daily alcohol consumption (ref: abstinent)	13.6	15.2		
Light drinkers	46.9	49.0	0.65 (0.43-0.99)	0.039
Moderate drinkers	17.6	15.7	0.58 (0.33-0.99)	0.050
Heavy drinkers	17.4	14.0	0.31 (0.13-0.65)	0.004
(At least one) road traffic crash (ref: no)	94.5	89.0		
Yes	2.9	3.3	1.31 (0.46-2.89)	0.552
Chronic conditions (ref: absence of the particular disorder)	-	-		
Angina, myocardial infarction, coronary artery disease	1.9	2.2	0.58 (0.09-1.90)	0.456
Stroke	0.3	0.4	3.32 (0.53-10.93)	0.104
Nephritic colic and urinary stones	0.5	0.6	0.00 (-) ^a	0.977
Glaucoma	3.0	4.5	1.60 (0.81-2.88)	0.143
Hearing difficulties	18.5	23.6	1.08 (0.71-1.59)	0.723
Joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism, rheumatoid polyarthritis	30.9	32.5	1.11 (0.76-1.60)	0.576
Gout and complications	0.9	1.1	0.91 (0.05-4.13)	0.929
Persistent dental and gum problems	2.1	1.6	0.78 (0.19-2.08)	0.667
Depression; feeling depressed, anxious or stressed	6.2	4.7	1.39 (0.76-2.37)	0.254
Sleep disorders	10.5	11.7	1.14 (0.71-1.78)	0.576
Cataract	1.0	2.5	1.79 (0.69-3.79)	0.175
Parkinson's disease	0.1	0.4	32.61 (14.21-65.17)	<0.001
Arteritis of the lower limbs, phlebitis, venous circulatory	4.2	3.9	1.35 (0.70-2.40)	0.335

	2007	2014		
	N	N		
	11,633	11,496		
	%	%	Hazard ratio	p-value
			(95% CI)	
disorders				
High blood pressure	19.5	24.9	1.10 (0.73-1.60)	0.646
Hemorrhoids	8.4	6.6	1.16 (0.61-2.00)	0.627
Diabetes	4.1	6.8	1.68 (0.89-2.92)	0.084
Biliary stones	0.4	0.5	0.00 (-) ^a	0.980
Neck pain, middle back pain, low back pain, sciatica	33.5	31.9	0.92 (0.63-1.33)	0.666
Retinal detachment	0.1	0.1	0.00 (-) ^a	0.987
Migraine	6.3	3.9	1.23 (0.61-2.23)	0.524
Year (ref: 2007)	-	-		
2008	-	-	0.54 (0.21-1.26)	0.162
2009	-	-	0.98 (0.47-2.05)	0.954
2010	-	-	1.40 (0.72-2.81)	0.333
2011	-	-	1.20 (0.60-2.45)	0.615
2012	-	-	0.95 (0.45-2.01)	0.890
2013	-	-	1.29 (0.65-2.64)	0.466
2014	-	-	1.86 (0.99-3.66)	0.062

a) Few cases of driving cessation among participants with these disorders lead to wide confidence intervals that include zero.

Table 8. Characteristics of participants in 2015 (sample for the analyses of mileage and avoided situations)

	(%)	Missing (%)
Gender		0 (0.0)
Women	965 (19.4)	
Men	4 008 (80.6)	
Family status		126 (2.5)
Living with a partner	4 155 (83.6)	
Divorced or separated	373 (7.5)	
Living alone or widow(-er)	319 (6.4)	132 (2.7)
Maximum daily alcohol consumption		
Abstinent	699 (14.1)	
Light drinkers	2 564 (51.6)	
Moderate drinkers	829 (16.7)	
Heavy drinkers	749 (15.1)	
Chronic conditions		
Angina, myocardial infarction, coronary artery disease	117 (2.4)	32 (0.6)
Stroke	18 (0.4)	24 (0.5)
Nephritic colic and urinary stones	25 (0.5)	25 (0.5)
Glaucoma	251 (5.1)	29 (0.6)
Hearing difficulties	885 (17.8) ^a	349 (7.0)
Joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism, rheumatoid polyarthritis	1 655 (33.3)	66 (1.3)
Gout and complications	52 (1.1)	26 (0.5)
Persistent dental and gum problems	91 (1.8)	27 (0.5)
Depression; feeling depressed, anxious or stressed	208 (4.2)	34 (0.7)
Sleep disorders	588 (11.8)	33 (0.7)
Cataract	127 (2.6)	27 (0.5)
Parkinson's disease	14 (0.3)	23 (0.5)
Arteritis of the lower limbs, phlebitis, venous circulatory disorders	151 (3.0)	28 (0.6)
High blood pressure	1 302 (26.2)	56 (1.1)
Hemorrhoids	342 (6.9)	32 (0.6)
Diabetes	321 (6.5)	32 (0.6)

	N (%)	Missing (%)
Biliary stones	21 (0.4)	25 (0.5)
Neck pain, middle back pain, low back pain, sciatica	1 661 (33.4)	69 (1.4)
Retinal detachment	12 (0.2)	24 (0.5)
Migraine	194 (3.9)	29 (0.6)
Avoided driving situations		236 (4.8)
Night	1 946 (39.1)	
Bad weather conditions	1 433 (28.8)	
Heavy traffic	1 055 (21.2)	
Glare conditions	697 (14.0)	
Long distances	598 (12.0)	
City	353 (8.4)	
Unknown route	287 (6.8)	
Parking	260 (6.2)	
Overtaking	163 (3.9)	
Driving alone	162 (3.9)	
Reverse drive	142 (3.4)	
Highway	139 (3.3)	
Major intersections	63 (1.5)	
Change lanes	57 (1.4)	
Roundabouts	23 (0.5)	
Left turns	18 (0.4)	

a) Question was asked differently from 2014 onwards

Table 9. Analysis of mileage (reported in 2015). Multivariable linear model

	N=4 166	Coefficient (95% CI)	p-value
Intercept		5 419 (4 589, 6 248)	<0.001
Gender (ref: women, n=761)			
Men	n=3 405	9 070 (8 400, 9 740)	<0.001
Age (centered at 70 years old)			
		-274 (-348, -199)	<0.001
Family status (ref: living with a partner, n=3 590)			
Divorced or separated	n=305	971 (94, 1 847)	0.030
Living alone or widow(-er)	n=271	724 (-196, 1 643)	0.123
Maximum daily alcohol consumption (ref: abstinent, n=592)			
Light drinkers	n=2 219	-67 (-743, 608)	0.846
Moderate drinkers	n=715	634 (-169, 1 437)	0.121
Heavy drinkers	n=640	876 (36, 1 715)	0.041
Chronic conditions (ref: absence of the particular disorder)			
Angina, myocardial infarction, coronary artery disease	n=101	769 (-681, 2 218)	0.298
Stroke	n=15	-5 737 (-9 450, -2 023)	0.002
Nephritic colic and urinary stones	n=21	811 (-2 325, 3 947)	0.612
Glaucoma	n=220	-1 434 (-2 432, -437)	0.005
Hearing difficulties	n=799	212 (-365, 788)	0.471
Joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism, rheumatoid polyarthritis	n=1 395	538 (42, 1 034)	0.034
Gout and complications	n=45	2 425 (308, 4 543)	0.025
Persistent dental and gum problems	n=74	57 (-1 644, 1 758)	0.948
Depression; feeling depressed, anxious or stressed	n=175	-415 (-1 550, 721)	0.474
Sleep disorders	n=494	-309 (-1 028, 409)	0.398
Cataract	n=109	-2 517 (-3 920, -1 114)	<0.001
Parkinson's disease	n=14	-3 758 (-7 598, 83)	0.055
Arteritis of the lower limbs, phlebitis, venous circulatory disorders	n=124	157 (-1 169, 1 482)	0.817
High blood pressure	n=1 130	278 (-229, 786)	0.282
Hemorrhoids	n=306	255 (-617, 1 127)	0.566
Diabetes	n=265	-426 (-1 347, 496)	0.365
Biliary stones	n=18	-1 453 (-4 852, 1 947)	0.402
Neck pain, middle back pain, low back pain, sciatica	n=1 396	-304 (-806, 199)	0.236
Retinal detachment	n=9	1 359 (-3 454, 6 172)	0.580
Migraine	n=167	236 (-918, 1 391)	0.688

Table 10. Analysis of mileage (reported in 2015). Multivariable linear model, sensitivity analysis. We broke down the groups formed by angina, myocardial infarction and coronary artery disease, arteritis of the lower limbs, phlebitis, venous circulatory disorders, and joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism and rheumatoid polyarthritis.

	N=4 166	Coefficient	p-value
		(95% CI)	
Intercept		5 383 (4 554, 6 212)	<0.001
Gender (ref: women, n=761)			
Men	n=3 405	9 152 (8 476, 9 828)	<0.001
Age (centered at 70 years old)			
		-277 (-351, -202)	<0.001
Family status (ref: living with a partner, n=3 590)			
Divorced or separated	n=305	980 (103, 1 857)	0.029
Living alone or widow(-er)	n=271	709 (-212, 1 629)	0.131
Maximum daily alcohol consumption (ref: abstinent, n=592)			
Light drinkers	n=2 219	-50 (-726, 625)	0.884
Moderate drinkers	n=715	662 (-141, 1 465)	0.106
Heavy drinkers	n=640	893 (54, 1 733)	0.037
Chronic conditions (ref: absence of the particular disorder)			
Angina, coronary artery disease	n=66	167 (-1 622, 1 955)	0.855
Myocardial infarction	n=36	1 905 (-501, 4 311)	0.121
Stroke	n=15	-5 748 (-9 464, -2 032)	0.002
Nephritic colic and urinary stones	n=21	882 (-2 257, 4 021)	0.582
Glaucoma	n=220	-1 470 (-2 469, -472)	0.004
Hearing difficulties	n=799	217 (-360, 794)	0.461
Joint or muscle pain	n=1 012	-4 (-557, 550)	0.989
Carpal tunnel syndrome	n=70	-50 (-1 794, 1 694)	0.955
Arthrosis, rheumatism	n=700	817 (174, 1 459)	0.013
Rheumatoid polyarthritis	n=37	398 (-1 978, 2 773)	0.743
Gout and complications	n=45	2 404 (286, 4 522)	0.026
Persistent dental and gum problems	n=74	152 (-1 550, 1 853)	0.861
Depression; feeling depressed, anxious or stressed	n=175	-418 (-1 554, 719)	0.471
Sleep disorders	n=494	-326 (-1 046, 394)	0.375
Cataract	n=109	-2 459 (-3 864, -1 055)	<0.001
Parkinson's disease	n=14	-3 845 (-7 686, -5)	0.050
Arteritis of the lower limbs	n=29	-1 818 (-4 508, 873)	0.185
Phlebitis	n=7	-68 (-5 493, 5 357)	0.980

	N=4 166	Coefficient	p-value
		(95% CI)	
Venous circulatory disorders	n=89	783 (-785, 2 350)	0.328
High blood pressure	n=1 130	293 (-215, 802)	0.258
Hemorrhoids	n=306	243 (-629, 1 116)	0.585
Diabetes	n=265	-449 (-1 372, 475)	0.341
Biliary stones	n=18	-1 369 (-4 768, 2 031)	0.430
Neck pain, middle back pain, low back pain, sciatica	n=1 396	-324 (-833, 184)	0.212
Retinal detachment	n=9	1 219 (-3 602, 6 040)	0.620
Migraine	n=167	198 (-957, 1 354)	0.737

Table 11. Analysis of avoided driving situations (driving at night, reported in 2015). Multivariable logistic model

	N=4 196	Odds ratio	p-value
		(95% CI)	
Intercept		1.68 (1.32-2.13)	<0.001
Gender (ref: women, n=768)			
Men	n=3 428	0.25 (0.20-0.30)	<0.001
Age (centered at 70 years old)		1.06(1.04-1.08)	<0.001
Family status (ref: living with a partner, n=3 617)			
Divorced or separated	n=306	1.02 (0.79-1.32)	0.856
Living alone or widow(-er)	n=273	0.91 (0.70-1.19)	0.488
Maximum daily alcohol consumption (ref: abstinent, n=597)			
Light drinkers	n=2 236	1.19 (0.98-1.45)	0.082
Moderate drinkers	n=720	1.07 (0.85-1.35)	0.559
Heavy drinkers	n=643	1.26 (0.99-1.60)	0.065
Chronic conditions (ref: absence of the particular disorder)			
Angina, myocardial infarction, coronary artery disease	n=101	0.93 (0.61-1.40)	0.731
Stroke	n=15	1.57 (0.55-4.61)	0.398
Nephritic colic and urinary stones	n=21	2.63 (1.08-6.77)	0.036
Glaucoma	n=222	1.25 (0.94-1.65)	0.125
Hearing difficulties	n=806	1.13 (0.96-1.33)	0.138
Joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism, rheumatoid polyarthritis	n=1 410	0.96 (0.83-1.11)	0.596
Gout and complications	n=48	1.01 (0.55-1.82)	0.979
Persistent dental and gum problems	n=74	1.04 (0.64-1.68)	0.875
Depression; feeling depressed, anxious or stressed	n=177	1.56 (1.13-2.17)	0.007
Sleep disorders	n=497	1.27 (1.04-1.56)	0.020
Cataract	n=108	1.26 (0.84-1.88)	0.260
Parkinson's disease	n=14	1.59 (0.54-4.71)	0.393
Arteritis of the lower limbs, phlebitis, venous circulatory disorders	n=126	0.70 (0.47-1.02)	0.064
High blood pressure	n=1 140	1.01 (0.88-1.17)	0.843
Hemorrhoids	n=308	1.13 (0.88-1.45)	0.326
Diabetes	n=274	1.17 (0.90-1.51)	0.245
Biliary stones	n=18	0.92 (0.34-2.45)	0.873
Neck pain, middle back pain, low back pain, sciatica	n=1 408	1.10 (0.95-1.27)	0.200
Retinal detachment	n=9	2.54 (0.64-12.42)	0.200
Migraine	n=172	1.03 (0.74-1.42)	0.878

Table 12. Analysis of avoided driving situations (driving with bad weather, reported in 2015). Multivariable logistic model

	N=4 196	Odds ratio (95% CI)	p-value
Intercept		0.49 (0.39-0.63)	<0.001
Gender (ref: women, n=768)			
Men	n=3 428	0.87 (0.71-1.06)	0.158
Age (centered at 70 years old)			
		1.06 (1.04-1.08)	<0.001
Family status (ref: living with a partner, n=3 617)			
Divorced or separated	n=306	1.21 (0.93-1.55)	0.152
Living alone or widow(-er)	n=273	1.29 (0.99-1.68)	0.059
Maximum daily alcohol consumption (ref: abstinent, n=597)			
Light drinkers	n=2 236	1.02 (0.84-1.25)	0.821
Moderate drinkers	n=720	0.90 (0.71-1.15)	0.400
Heavy drinkers	n=643	0.96 (0.75-1.24)	0.760
Chronic conditions (ref: absence of the particular disorder)			
Angina, myocardial infarction, coronary artery disease	n=101	0.99 (0.64-1.50)	0.955
Stroke	n=15	3.06 (1.09-9.24)	0.036
Nephritic colic and urinary stones	n=21	0.92 (0.32-2.28)	0.860
Glaucoma	n=222	1.05 (0.78-1.40)	0.748
Hearing difficulties	n=806	1.02 (0.86-1.21)	0.793
Joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism, rheumatoid polyarthritis	n=1 410	1.01 (0.87-1.17)	0.905
Gout and complications	n=48	1.04 (0.54-1.90)	0.913
Persistent dental and gum problems	n=74	0.86 (0.50-1.43)	0.574
Depression; feeling depressed, anxious or stressed	n=177	1.41 (1.02-1.95)	0.035
Sleep disorders	n=497	1.04 (0.84-1.29)	0.697
Cataract	n=108	0.91 (0.59-1.38)	0.664
Parkinson's disease	n=14	1.61 (0.52-4.67)	0.384
Arteritis of the lower limbs, phlebitis, venous circulatory disorders	n=126	0.96 (0.64-1.40)	0.821
High blood pressure	n=1 140	0.98 (0.84-1.14)	0.785
Hemorrhoids	n=308	1.05 (0.81-1.36)	0.720
Diabetes	n=274	1.00 (0.76-1.31)	0.978
Biliary stones	n=18	0.29 (0.05-1.03)	0.101
Neck pain, middle back pain, low back pain, sciatica	n=1 408	0.89 (0.76-1.03)	0.113
Retinal detachment	n=9	1.15 (0.24-4.49)	0.846
Migraine	n=172	1.00 (0.71-1.40)	0.998

Table 13. Analysis of avoided driving situations (driving with heavy traffic, reported in 2015). Multivariable logistic model

	N=4 196	Odds ratio (95% CI)	p-value
Intercept		0.22 (0.17-0.29)	<0.001
Gender (ref: women, n=768)			
Men	n=3 428	1.39 (1.11-1.76)	0.005
Age (centered at 70 years old)			
		1.01 (0.99-1.04)	0.410
Family status (ref: living with a partner, n=3 617)			
Divorced or separated	n=306	0.98 (0.72-1.30)	0.868
Living alone or widow(-er)	n=273	0.89 (0.64-1.21)	0.471
Maximum daily alcohol consumption (ref: abstinent, n=597)			
Light drinkers	n=2 236	0.94 (0.75-1.18)	0.585
Moderate drinkers	n=720	1.06 (0.81-1.37)	0.683
Heavy drinkers	n=643	0.84 (0.63-1.10)	0.206
Chronic conditions (ref: absence of the particular disorder)			
Angina, myocardial infarction, coronary artery disease	n=101	1.70 (1.10-2.58)	0.014
Stroke	n=15	0.22 (0.01-1.08)	0.139
Nephritic colic and urinary stones	n=21	0.56 (0.13-1.66)	0.351
Glaucoma	n=222	1.21 (0.88-1.65)	0.228
Hearing difficulties	n=806	1.01 (0.83-1.21)	0.947
Joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism, rheumatoid polyarthritis	n=1 410	0.99 (0.84-1.17)	0.934
Gout and complications	n=48	1.31 (0.67-2.42)	0.405
Persistent dental and gum problems	n=74	0.78 (0.42-1.38)	0.424
Depression; feeling depressed, anxious or stressed	n=177	1.45 (1.01-2.04)	0.038
Sleep disorders	n=497	1.07 (0.84-1.34)	0.597
Cataract	n=108	0.82 (0.50-1.31)	0.428
Parkinson's disease	n=14	1.70 (0.52-4.96)	0.347
Arteritis of the lower limbs, phlebitis, venous circulatory disorders	n=126	1.05 (0.67-1.60)	0.821
High blood pressure	n=1 140	1.08 (0.91-1.27)	0.369
Hemorrhoids	n=308	1.14 (0.86-1.50)	0.363
Diabetes	n=274	1.02 (0.76-1.36)	0.875
Biliary stones	n=18	1.02 (0.29-2.89)	0.972
Neck pain, middle back pain, low back pain, sciatica	n=1 408	0.97 (0.82-1.14)	0.703
Retinal detachment	n=9	0.95 (0.14-4.09)	0.947
Migraine	n=172	0.88 (0.59-1.29)	0.526

Table 14. Analysis of avoided driving situations (driving with glare conditions, reported in 2015). Multivariable logistic model

	N=4 196	Odds ratio (95% CI)	p-value
Intercept		0.27 (0.20-0.36)	<0.001
Gender (ref: women, n=768)			
Men	n=3 428	0.46 (0.36-0.59)	<0.001
Age (centered at 70 years old)			
		1.05 (1.02-1.08)	<0.001
Family status (ref: living with a partner, n=3 617)			
Divorced or separated	n=306	0.89 (0.63-1.24)	0.520
Living alone or widow(-er)	n=273	0.89 (0.62-1.25)	0.499
Maximum daily alcohol consumption (ref: abstinent, n=597)			
Light drinkers	n=2 236	0.91 (0.71-1.18)	0.476
Moderate drinkers	n=720	0.77 (0.56-1.05)	0.102
Heavy drinkers	n=643	1.35 (0.99-1.85)	0.056
Chronic conditions (ref: absence of the particular disorder)			
Angina, myocardial infarction, coronary artery disease	n=101	0.72 (0.36-1.30)	0.308
Stroke	n=15	1.45 (0.32-4.70)	0.572
Nephritic colic and urinary stones	n=21	1.36 (0.39-3.75)	0.581
Glaucoma	n=222	1.34 (0.93-1.89)	0.102
Hearing difficulties	n=806	1.05 (0.84-1.31)	0.662
Joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism, rheumatoid polyarthritis	n=1 410	1.10 (0.91-1.33)	0.321
Gout and complications	n=48	0.97 (0.39-2.08)	0.941
Persistent dental and gum problems	n=74	1.40 (0.77-2.42)	0.241
Depression; feeling depressed, anxious or stressed	n=177	1.21 (0.81-1.77)	0.344
Sleep disorders	n=497	1.40 (1.08-1.78)	0.009
Cataract	n=108	1.26 (0.75-2.01)	0.360
Parkinson's disease	n=14	1.70 (0.38-5.64)	0.424
Arteritis of the lower limbs, phlebitis, venous circulatory disorders	n=126	0.87 (0.52-1.39)	0.571
High blood pressure	n=1 140	1.09 (0.90-1.33)	0.383
Hemorrhoids	n=308	0.98 (0.70-1.35)	0.921
Diabetes	n=274	1.17 (0.83-1.64)	0.353
Biliary stones	n=18	1.85 (0.57-5.14)	0.261
Neck pain, middle back pain, low back pain, sciatica	n=1 408	1.19 (0.98-1.44)	0.082
Retinal detachment	n=9	2.47 (0.50-9.81)	0.217
Migraine	n=172	1.02 (0.66-1.53)	0.930

Table 15. Analysis of avoided driving situations (driving over long distances, reported in 2015). Multivariable logistic model

	N=4 196	Odds ratio (95%CI)	p-value
Intercept		0.28 (0.20-0.38)	<0.001
Gender (ref: women, n=768)			
Men	n=3 428	0.36 (0.28-0.47)	<0.001
Age (centered at 70 years old)			
		1.06 (1.03-1.09)	<0.001
Family status (ref: living with a partner, n=3 617)			
Divorced or separated	n=306	1.12 (0.80-1.56)	0.494
Living alone or widow(-er)	n=273	1.30 (0.92-1.81)	0.122
Maximum daily alcohol consumption (ref: abstinent, n=597)			
Light drinkers	n=2 236	1.02 (0.78-1.33)	0.910
Moderate drinkers	n=720	0.81 (0.58-1.14)	0.226
Heavy drinkers	n=643	0.99 (0.69-1.41)	0.944
Chronic conditions (ref: absence of the particular disorder)			
Angina, myocardial infarction, coronary artery disease	n=101	1.03 (0.53-1.85)	0.918
Stroke	n=15	3.46 (1.05-10.03)	0.027
Nephritic colic and urinary stones	n=21	0.39 (0.02-1.90)	0.359
Glaucoma	n=222	1.08 (0.71-1.60)	0.706
Hearing difficulties	n=806	0.95 (0.74-1.22)	0.708
Joint or muscle pain, carpal tunnel syndrome, arthrosis, rheumatism, rheumatoid polyarthritis	n=1 410	0.99 (0.80-1.21)	0.917
Gout and complications	n=48	0.52 (0.12-1.45)	0.276
Persistent dental and gum problems	n=74	1.21 (0.60-2.23)	0.570
Depression; feeling depressed, anxious or stressed	n=177	1.80 (1.22-2.61)	0.003
Sleep disorders	n=497	1.33 (1.01-1.73)	0.036
Cataract	n=108	0.94 (0.51-1.62)	0.840
Parkinson's disease	n=14	1.32 (0.20-4.96)	0.716
Arteritis of the lower limbs, phlebitis, venous circulatory disorders	n=126	1.21 (0.73-1.93)	0.438
High blood pressure	n=1 140	0.92 (0.73-1.14)	0.435
Hemorrhoids	n=308	1.03 (0.71-1.45)	0.885
Diabetes	n=274	1.17 (0.79-1.68)	0.424
Biliary stones	n=18	0.75 (0.11-2.77)	0.705
Neck pain, middle back pain, low back pain, sciatica	n=1 408	1.08 (0.87-1.33)	0.487
Retinal detachment	n=9	0.72 (0.04-4.11)	0.758
Migraine	n=172	1.32 (0.85-1.97)	0.197

Table 16. Prevalence evolution from 2007 to 2014 (sample for the analysis of risk of road traffic crash)

	2007	2014	
	N=12,460	N=11,670	
	n (%)	n (%)	Variation (%)
Angina, coronary artery disease	128 (1.0)	141 (1.2)	17.6
Myocardial infarction	125 (1.0)	114 (1.0)	-2.6
Stroke	38 (0.3)	50 (0.4)	40.5
Nephritic colic and urinary stones	68 (0.5)	73 (0.6)	14.6
Glaucoma	380 (3.0)	528 (4.5)	48.4
Hearing difficulties	2,286 (18.3)	2,738 (23.5)	27.9
Joint or muscle pain	2,724 (21.9)	2,709 (23.2)	6.2
Carpal tunnel syndrome	246 (2.0)	180 (1.5)	-21.9
Arthrosis, rheumatism	1,778 (14.3)	1,973 (16.9)	18.5
Rheumatoid polyarthritis	92 (0.7)	83 (0.7)	-3.7
Gout and complications	115 (0.9)	134 (1.1)	24.4
Persistent dental and gum problems	262 (2.1)	191 (1.6)	-22.2
Depression	81 (0.7)	44 (0.4)	-42.0
Feeling depressed, anxious or stressed	723 (5.8)	529 (4.5)	-21.9
Sleep disorders	1,312 (10.5)	1,360 (11.7)	10.7
Cataract	122 (1.0)	288 (2.5)	152.0
Parkinson's disease	11 (0.1)	42 (0.4)	307.7
Arteritis of the lower limbs	81 (0.7)	94 (0.8)	23.9
Phlebitis	20 (0.2)	29 (0.2)	54.8
Venous circulatory disorders	455 (3.7)	339 (2.9)	-20.5
High blood pressure	2,448(19.6)	2,894 (24.8)	26.2
Hemorrhoids	1,035 (8.3)	770 (6.6)	-20.6
Diabetes	544 (4.4)	790 (6.8)	55.1
Biliary stones	51 (0.4)	59 (0.5)	23.5
Neck pain	1,807 (14.5)	1,572 (13.5)	-7.1
Middle back pain	508 (4.1)	443 (3.8)	-6.9
Low back pain	2,929 (23.5)	2,707 (23.2)	-1.3
Sciatica	468 (3.8)	394 (3.4)	-10.1
Retinal detachment	18 (0.1)	16 (0.1)	-5.1
Migraine	781 (6.3)	451 (3.9)	-38.3
Varicose and ulcerous legs	326 (2.6)	299 (2.6)	-2.1
Cholesterol, hyperlipidemia, triglycerides	2,547 (20.4)	2,360 (20.2)	-1.1
Hyperthyroidism, goiter, hypothyroidism	395 (3.2)	459 (3.9)	24.1
Sjogren's syndrome	72 (0.6)	125 (1.1)	85.4
Asthma	223 (1.8)	197 (1.7)	-5.7
Chronic bronchitis	161 (1.3)	204 (1.7)	35.3
Respiratory problems in your daily activities	193 (1.5)	245 (2.1)	35.5
Influenza	201 (1.6)	100 (0.9)	-46.9

Recurrent respiratory infections	323 (2.6)	240 (2.1)	-20.7
Recurrent urinary infections	69 (0.6)	81 (0.7)	25.3
Hepatic disease	54 (0.4)	58 (0.5)	14.7
Hiatal hernia, reflux oesophagitis	952 (7.6)	1,041 (8.9)	16.8
Chronic intestinal transit disorder	549 (4.4)	536 (4.6)	4.2
Ulcer of stomach or duodenum	80 (0.6)	67 (0.6)	-10.6
Psoriasis	403 (3.2)	381 (3.3)	0.9
Eczema	378 (3.0)	331 (2.8)	-6.5
Cancer	168 (1.3)	327 (2.8)	107.8
Anaemia	20 (0.2)	21 (0.2)	12.1

SUPPLEMENTARY FIGURE

