Cognitive hostility predicts all-cause mortality irrespective of behavioural risk at late middle and older age

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Background: Most but not all evidence supports hostility-related attributes to increase mortality risk. However, studies usually include single attributes, their effects have been studied predominantly in younger populations, and behavioural pathways explaining the mortality effect seem to differ by age. We examined the relationship between all-cause mortality and cognitive hostility, anger, aggression and rebelliousness, and their independence of health behaviours in a late middle-aged and older population.

Methods: Data were derived from the longitudinal Dutch Study of Medical Information and Lifestyles in the city of Eindhoven, in the Southeast of the Netherlands study among 2679 late middle-aged and older Dutch people. Psychological characteristics were self-reported in 2004/2005, and mortality was monitored from 2005 to 2010. Cox regression analyses were used to calculate the mortality risk by each unique psychological variable with additional adjustments for the other psychological variables and for health behaviours. Baseline adjustments included age, sex, educational level and prevalent morbidity. Results: Cognitive hostility was associated with all-cause mortality, independent of health behaviours (on a scale ranging from 6 to 30, the hazard ratio (HR) was 1.05; 95% confidence interval [95% CI]: 1.01–1.09). Anger, aggression and rebelliousness were not associated with mortality risk. Conclusions: In diminishing excess mortality risks, hostile cognitions might be acknowledged separately and additionally to the risk posed by unhealthy lifestyles.

Introduction

The importance of psychological risk factors for mortality is supported by evidence, demonstrating the adverse influence of specific psychological attributes, such as (cognitive) hostility, anger and aggression,¹⁻⁷ though such associations have not been confirmed in all studies.⁸ Possible biological mechanisms by which these attributes may increase health risk include, among others, sustained psychophysiological reactivity⁹⁻¹¹ and adverse health behaviours, such as smoking, heavy drinking and physical inactivity.³⁻¹²,¹³

Cognitive hostility, anger and aggression can be regarded as different components of a multifaceted hostility construct. Cognitive hostility can be defined as ‘negative beliefs about and attitudes towards others’ (e.g. cynicism and mistrust).¹⁴ Anger is the emotional component and is defined as an unpleasant emotion ranging in intensity from irritation or annoyance to fury or rage.¹⁴ Aggression involves a variety of verbal and physical behaviours, defined as ‘attacking, destructive or hurtful actions’.¹⁴ Although these constructs are interrelated and often co-occur, they each refer to a unique part of the broader hostility construct.¹⁵

A similar psychological attribute, rebelliousness was recently found to be associated with cognitive hostility.¹⁶ Being a rebellious person means that one wants to oppose a perceived requirement ‘in order to obtain fun and excitement’ (proactive rebelliousness) or ‘because the requirement is judged to be unfair or unreasonable’ (reactive rebelliousness).¹⁷ More than cognitive hostility, rebelliousness might be related to mortality via opposing and obstructing health campaigns. Previous studies already showed that a state of rebelliousness was indeed associated with maintaining maladaptive health behaviours as well as with refraining from adopting new health-promoting ones.¹⁶,¹⁸ Certainly, this warrants a further examination of the effect of rebelliousness on mortality; of whether or not this effect is in concordance with the adverse effects of cognitive hostility, anger and aggression; and of the extent to which behavioural pathways contribute to mortality effects of these hostility-related attributes.

Both the effects on mortality of hostility-related attributes and behavioural contributions may be age related. Although it is suggested that hostility decreases with age,¹³ the three studies that have specifically focused on older populations still found increased mortality risks among the most hostile or angry persons when compared with the least hostile or angry.¹⁶,⁷ This might be explained by a longer duration of exposure to these adverse attributes in older people combined with the ageing body becoming less able to repair damage.¹⁹ In contrast with findings in a younger (aged 42–60 years), male population showing that cynical hostility effects on mortality were primarily mediated by behavioural risk factors, the effects of hostility-related attributes on mortality in these older populations hardly changed after controlling for these risk factors, suggesting that explaining mechanisms might vary with age. However, methodological characteristics of these studies prevent from making strong inferences. Neither of these three studies included all the elements of the multifaceted hostility construct, and two out of three were in specific samples:
post-menopausal women aged 50–79 years and catholic clergy members of mean age 75.4 years.

Dutch longitudinal data were used to first address whether these attributes induce premature mortality and secondly whether health behaviours contribute to these associations in a late middle-aged and older population.

**Methods**

**Design and participants**

Longitudinal self-report and medical data came from a dynamic cohort study: Study of Medical Information and Lifestyles in the city of Eindhoven, in the Southeast of the Netherlands (SMILE).20

Starting in 2002, individuals who were enrolled in one of the nine participating primary health-care centres were invited to participate. The national compulsory medical insurance scheme leads to nearly every Dutch individual being registered with a general practitioner, offering SMILE as an unselected practice population. Informed consent included self-report questionnaires and linkage of questionnaire data to medical records including mortality registration. The present study used data of the participants aged ≥55 years that were collected between November 2005 (baseline measures) and the end of the follow-up period, in November 2010. Within this subsample of the total SMILE population, a more extensive and detailed data collection took place, in particular, of the psychosocial characteristics. Of the 5001 participants aged ≥55 years that consented to complete the self-report questionnaires (response rate, 44.8%), 3314 participants (66%) also consented to linkage to their medical data. We excluded individuals with missing data on demographics ($N = 82$) and health behaviours ($N = 553$). The final sample eligible for analysis comprised 2679 participants (24.0% of the target population). During follow-up, 242 people died.

**Measures**

Rebelliousness, demographics, prevalent health status and health behaviours were measured at baseline in 2005. Cognitive hostility, anger and aggression were measured in 2004; these were assumed to be stable until 2005. Mortality was registered continuously from baseline (1 November 2005) until 1 November 2010.

**Cognitive hostility, anger and aggression**

Cognitive hostility, anger and aggression were measured by the Aggression Questionnaire.21,22 Cognitive hostility (six items), anger (seven items) and verbal aggression (four items) were rated on a 5-point Likert scale, ranging from 1 (‘totally disagree’) to 5 (‘totally agree’) and summed to obtain subscale scores, with higher scores indicating more cognitive hostility, anger and aggression, respectively. Example items are: ‘Other people always seem to get the breaks’ (cognitive hostility), ‘I sometimes feel like a powder keg ready to explode’ (anger), ‘I can’t help getting into arguments when people disagree with me’ (verbal aggression). The Aggression Questionnaire has proven valid and reliable.21–23

**Rebelliousness**

Rebelliousness was measured by means of the self-report Social Reactivity Scale (SRS) with two subscale scores reflecting the degree of proactive rebelliousness and reactive rebelliousness.24 Both subscales consist of seven items, of which each item is rated on a 3-point Likert scale with responses scored as: 0 (not rebellious), 1 (not sure) and 2 (rebellious), which were summed to obtain subscale scores, with higher scores indicating more proactive and reactive rebelliousness. An example item of proactive rebelliousness is: ‘Do you find it exciting to do something ‘shocking’?’, with response options (2) yes, often, (0) no, hardly ever, (1) not sure. An example of a reactive rebelliousness item is: ‘If people are unkind to you, do you feel you should be (2) unkind back, (0) understanding, (1) not sure?’. The SRS has been found moderately valid and reliable.16

**Health behaviours**

Data were obtained on: (i) smoking (never, former and current); (ii) alcohol consumption, which was defined as number of alcoholic beverages per week; and (iii) physical activity, indicated by the hours spend per week on (different kinds of) sports, based on the Short Questionnaire to Assess Health-enhancing physical activity (SQUASH), which has been judged fairly reliable and valid.25

**Mortality**

Time to event (death) was the outcome measure, which was defined as the time from baseline (1 November 2005) to the date of death ($n = 242$) or complete follow-up (1 November 2010, $n = 2437$).

**Covariates**

Age, sex, educational level and prevalent somatic morbidity were included in all analyses. Highest education completed was classified into high education (pre-university secondary education, higher vocational education and university education), intermediate education (apprenticeship system, general secondary education and intermediate vocational education) and low education (primary and lower secondary vocational education). Prevalent somatic morbidity, diagnosed before 1 November 2005, was retrieved from general practitioner (GP)-registered medical records, which contain International Classification of Primary Care (ICPC) diagnose codes. Morbidity was dichotomized into being diagnosed (1) or not (0) with at least one of the four age-related non-communicable diseases (cardiovascular diseases, cancers, chronic respiratory diseases and diabetes) that are current spearheads of WHO policy.26–28

**Data analyses**

Missing values on the cognitive hostility, anger, aggression or rebelliousness subscales ($N = 506$) were imputed by means of multiple imputation methods in Statistical Package for the Social Sciences (SPSS) 17.0, in which the missing value is predicted by regression analyses of the complete cases.29,30 Age, sex and educational level were entered as predictor variables of the missing values. We created five sets of imputed data,31 and those estimations were combined into one set of pooled data. The analyses described below are based on the pooled data set.

Bi-variate correlations were performed to determine associations among psychological attributes and health behaviours. The prediction of mortality by cognitive hostility, anger, aggression and proactive and reactive rebelliousness was studied by means of Cox proportional hazard models; adjusted for age, sex, educational level and prevalent somatic morbidity (Model 1), additionally adjusted for the other four psychological attributes under study (Model 2) and for the health behaviours (Model 3). The analyses in Model 3 were repeated with the significant psychological predictors categorized in tertiles for the purpose of examining the group effect. The proportional hazard assumption was examined by calculating the interaction between each psychological variable and the logarithm of time, which should result in the interaction term being non-significant. We tested for multicollinearity of the psychological variables by means of calculating the variation inflation factors (VIFs). As a rule of thumb, these VIFs are not allowed to exceed 10.32 Curvilinearity was examined in all three models by additionally including the quadratic terms of the psychological attributes in the models. Interactions of the psychological attributes with each other, as well as interactions of the psychological attributes with the covariates in their association with mortality were...
also examined in Models 2 and 3. To check the robustness of the findings, the results based on the imputed data were compared with the results of the complete case analyses.

**Results**

Of the 5001 respondents who filled out the questionnaires, 34% did not consent to the use of their medical data, and not all data were complete. We examined the differences in socio-demographics and hostility-related attributes between the people who consented and those who did not consent to the linkage with medical data. The people who consented did not differ by age, sex or educational level from the persons who did not consent. The people who consented had lower mean levels of hostility and proactive rebelliousness (11.7 vs. 12.2 for hostility, \( P = 0.02 \) and 1.1 vs. 1.3, \( P < 0.01 \) for proactive rebelliousness, respectively). Further, the respondents with missing data on the psychological variables (\( N = 306 \)) measured at baseline did not differ with regard to age, sex, educational level and mortality from the participants with complete data at baseline.

A total of 242 participants (9%) died during the observation period and 985 (37%) were diagnosed with at least one somatic disease before baseline (Table 1). The mean scores on the psychological measures were relatively low when compared with the possible range of the scales. About one-fifth of the population smoked, one-tenth was abstinent from alcohol and 7% drank excessively. About half of the participants did not engage in any kind of sports at all. Survivors were younger; they reported lower levels of cognitive hostility and anger; they were more likely to be male; less likely to smoke; more likely to engage in sports; and they were diagnosed less frequently with a somatic disease compared with the people who died during follow-up.

All psychological attributes correlated positively and significantly with each other, with the strongest correlations found between cognitive hostility and anger (Pearson’s \( r = 0.51 \)), and between anger and verbal aggression (\( r = 0.49 \)) (Table 2). Smoking correlated (based on Spearman’s rho correlations) positively and significantly with all five psychological variables; the number of alcoholic beverages per week was significantly associated with anger and reactive rebelliousness; and no psychological variable correlated significantly with sports.

People who reported more cognitive hostility had an increased risk of all-cause mortality (Table 3). This effect remained even after additional adjustments for the other psychological variables (Model 2) and for health behaviours (Model 3). With each unit increase in cognitive hostility (1 point on a scale of 6–30) the mortality risk was raised by 5% [hazard ratio (HR) = 1.05, \( P < 0.01 \), Model 3]. Neither anger, verbal aggression, nor rebelliousness predicted all-cause mortality. We examined the group effect of cognitive hostility by categorising this variable into tertiles; the highest scoring 33% of this sample had a 57% higher risk [95% confidence interval (CI) 1.06–2.32, \( P = 0.03 \)] of premature mortality when compared with the lowest scoring tertile (not tabulated). The models satisfied the proportional hazard function; all interaction terms were non-significant. The VIFs of the personality characteristics in these models did not exceed two, indicating that there were no collinear effects (not tabulated).

Prevalent morbidity hardly affected the associations between the psychological characteristics and mortality; without adjustment for prevalent morbidity, the HRs for cognitive hostility, anger and rebelliousness were 0.01 higher, and for verbal aggression, it remained the same. Further, the results neither differed between men and women nor across different age groups, different educational levels.

### Table 1 Demographic, personality and lifestyle characteristics (\( n = 2679 \)) for the total population and by survival status

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Total population</th>
<th>Survivors (( N = 2437 ))</th>
<th>Non-survivors (( N = 242 ))</th>
<th>( P )-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (range 55–92 years)</td>
<td>68.7 (8.3)</td>
<td>68.1 (8.0)</td>
<td>75.4 (8.4)</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Cognitive hostility (theoretical range 6–30)</td>
<td>11.7 (4.7)</td>
<td>11.4 (4.7)</td>
<td>12.9 (5.1)</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>Anger (theoretical range 7–35)</td>
<td>14.7 (5.2)</td>
<td>14.5 (5.2)</td>
<td>15.3 (5.6)</td>
<td>0.04</td>
</tr>
<tr>
<td>Verbal aggression (theoretical range 4–20)</td>
<td>8.4 (2.6)</td>
<td>8.3 (2.6)</td>
<td>8.7 (2.9)</td>
<td>0.07</td>
</tr>
<tr>
<td>Proactive rebelliousness (theoretical range 0–14)</td>
<td>1.1 (1.5)</td>
<td>1.0 (1.5)</td>
<td>1.2 (1.6)</td>
<td>0.17</td>
</tr>
<tr>
<td>Reactive rebelliousness (theoretical range 0–14)</td>
<td>3.9 (2.9)</td>
<td>3.9 (2.9)</td>
<td>4.0 (3.2)</td>
<td>0.69</td>
</tr>
</tbody>
</table>

\( n \) (%)

| Men                                           | 1268 (47)        | 1124 (46)                   | 144 (60)                       | < 0.01        |
| Current smoking                               | 507 (19)         | 451 (19)                    | 56 (23)                        | < 0.01        |
| Abstinence                                    | 280 (11)         | 245 (10)                    | 35 (15)                        | 0.10          |
| Excessive alcohol consumption (>21 glasses per week) | 196 (7)     | 178 (7)                     | 18 (7)                         | < 0.01        |
| Physical inactivity (no sports)              | 1467 (55)        | 1297 (53)                   | 170 (70)                       | < 0.01        |
| Prevalent morbidity                           | 985 (37)         | 819 (34)                    | 166 (69)                       | < 0.01        |

*For the continuous variables, the \( P \)-value is based on \( t \)-testing; for the categorical variables, the \( P \)-value is based on chi-square testing.

### Table 2 Bi-variate correlations among personality variables and health behaviours

<table>
<thead>
<tr>
<th>Personality variables</th>
<th>Anger*</th>
<th>Verbal aggression*</th>
<th>Proactive rebelliousness*</th>
<th>Reactive rebelliousness*</th>
<th>Smokingb</th>
<th>Alcohol use*</th>
<th>Sports*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive hostility</td>
<td>0.51*</td>
<td>0.42*</td>
<td>0.12*</td>
<td>0.09*</td>
<td>0.05**</td>
<td>0.01</td>
<td>-0.02</td>
</tr>
<tr>
<td>Anger</td>
<td>0.49*</td>
<td>0.17*</td>
<td>0.19*</td>
<td>0.08*</td>
<td>0.04*</td>
<td>0.01</td>
<td>0.03</td>
</tr>
<tr>
<td>Verbal aggression</td>
<td>0.16*</td>
<td>0.14*</td>
<td>0.14*</td>
<td>0.03</td>
<td>0.00*</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Proactive rebelliousness</td>
<td>0.20*</td>
<td>0.14*</td>
<td>0.11*</td>
<td>0.00*</td>
<td>0.01*</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Reactive rebelliousness</td>
<td>0.07*</td>
<td>0.11*</td>
<td>0.11*</td>
<td>0.00*</td>
<td>0.01*</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Smoking</td>
<td>0.20*</td>
<td>0.14*</td>
<td>0.11*</td>
<td>0.01*</td>
<td>0.00*</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Alcohol use</td>
<td>0.07*</td>
<td>0.11*</td>
<td>0.10*</td>
<td>0.01*</td>
<td>0.00*</td>
<td>0.03</td>
<td>0.03</td>
</tr>
</tbody>
</table>

\( a \): Pearson’s \( r \) correlations \( \text{b}: \) Spearman’s rho correlations

\( *P < 0.01; **P < 0.05 \)
and for people with or without prevalent somatic disease, for there were no statistically significant interactions between the psychological variables and these covariates in predicting mortality (results not shown). Neither were there significant interactions between the psychological variables. None of the quadratic terms were statistically significant, indicating the absence of curvilinear associations. Robustness of the findings based on the imputed data was checked by comparing these findings to the results from the analyses, including complete cases only ($N = 2173$); the results were similar. To exclude reversed causation, we re-ran the analyses by excluding deaths in the first 2 years of follow-up. This left us with 150 deaths. The HR for cognitive hostility in the fully controlled model (table 3, Model 3) remained significant: HR 1.06, 95% CI 1.01–1.11, $P = 0.01$.

### Discussion

The results showed a positive relationship between cognitive hostility and mortality in this late middle-aged and older population, irrespective of unhealthy lifestyles or the other related psychological variables. Anger, aggression and rebelliousness were not associated with the risk of mortality in this population.

Our findings that expressed adverse psychological responses are less harmful for longevity than adverse cognitions among older people are in line with previous findings on expressed psychological responses being less harmful than internally experienced psychological responses in an older population.\(^7\) A possible explanation could be that the low mean values of the expressed responses anger, aggression and rebelliousness within this population are simply not high or ‘toxic’ enough to provoke an untimely death. Previous studies providing descriptive for these psychological characteristics reported higher mean values, albeit in much younger populations.\(^11,22\) However, also in younger populations, hostile cognitions, rather than the behavioural and emotional components of hostility, were found to be significantly predictive of all-cause mortality, as was shown in a recent large-scale observational study with a 12.7-year follow-up by Nabi \textit{et al}.\(^5\). Although we cannot entirely rule out that the null findings for anger, aggression and rebelliousness are caused by low mean levels of these characteristics, it seems more likely that only hostile cognitions are of importance for longevity not only in our population of late middle-aged and older people but also in the general population.

We expected that the effect of cognitive hostility on mortality would be attenuated by health behaviours, as cognitive hostility has been found to be predictive of smoking, excessive drinking and avoidance of exercise in previous studies,\(^12,13\) which lifestyles in turn increase the mortality risk.\(^33\) Everson \textit{et al}.\(^3\) found that the behavioural risk factors substantially attenuated the association between hostility and all-cause and cardiovascular (CVD) mortality in a younger population (men aged 42–60 years). In the present study, relatively high hostile people were significantly more often current smokers when compared with low hostile people (table 2), and smoking predicted mortality as well (not tabulated). However, we found neither attenuation nor any significant interaction between smoking and cognitive hostility. Apparently, the adverse effects of both cognitive hostility and smoking on mortality are unique. Our findings are consistent with the observation that behavioural risk factors did not influence hostility–mortality association in the three other studies in either older populations.\(^1,6,7\)

Some methodological limitations need to be acknowledged. Cognitive hostility, anger and aggression were measured in 2004, but they were treated in the analyses as though they were measured at baseline (2005), for we assumed stability of these variables for this 1 year. Although there is meta-analytic evidence that personality might change, even in old age,\(^34\) we believe that, considering the relatively short time period of 1 year, it is unlikely that this has caused our results to be biased.

A substantial part of the respondents (34%) did not consent to the use of their medical data, and not all data were complete. We cannot rule out selection bias due to consent to the use of medical data in our results, but since data for comparison on the outcome were not available to us, it is unknown whether and how this selection might have biased our findings. The respondents with missing data on the psychological variables measured at baseline did not differ on sociodemographics and mortality from the participants with complete data at baseline. The results from the multiple imputation analyses also did not differ from analyses using the complete cases only. Therefore, we do not expect our findings to be substantially biased by these missing data.

Possibly, the effects of hostility on the outcome might have been different if we had used cause-specific mortality. Unfortunately, these data were not available. Hostility in previous studies has often been associated with cardiac mortality, both in the aetiology of and prognosis,\(^35,36\) with cardiac disease (mortality). Proposed mechanisms specifically for cardiac health include lifestyle factors\(^7\) though not in all studies;\(^1\) blood pressure;\(^37\) atherosclerosis;\(^38\) obesity and insulin resistance;\(^39\) and autonomic control.\(^40\) The present results show that hostility probably also exerts broader effects on survival. In future studies, we need to include other causes of death and consider alternative pathways.

### Conclusions

Premature mortality in late middle-aged and older people is not only induced by unhealthy behaviours but also by psychological

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**Table 3** HRs (95% CIs) of all-cause mortality by cognitive hostility, anger, aggression and rebelliousness, adjusted for age, sex, educational level and prevalent somatic disease (Model 1), additionally adjusted for the other four personality variables (Model 2) and for the health behaviours (Model 3)

<table>
<thead>
<tr>
<th>Personality variables</th>
<th>All-cause mortality</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1: age, sex, education and prevalent morbidity</td>
<td>Model 2: age, sex, education, prevalent morbidity and other personality variables</td>
<td>Model 3: age, sex, education, prevalent morbidity, other personality variables, and health behaviours*</td>
<td></td>
</tr>
<tr>
<td>Cognitive hostility</td>
<td>1.04 (1.01–1.07)</td>
<td>&lt;0.01</td>
<td>1.05 (1.02–1.09)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Anger</td>
<td>1.01 (0.98–1.03)</td>
<td>0.62</td>
<td>0.99 (0.95–1.02)</td>
<td>0.50</td>
</tr>
<tr>
<td>Verbal aggression</td>
<td>1.00 (0.96–1.05)</td>
<td>0.88</td>
<td>0.97 (0.92–1.03)</td>
<td>0.34</td>
</tr>
<tr>
<td>Proactive rebelliousness</td>
<td>1.05 (0.97–1.14)</td>
<td>0.23</td>
<td>1.04 (0.96–1.13)</td>
<td>0.37</td>
</tr>
<tr>
<td>Reactive rebelliousness</td>
<td>1.03 (0.95–1.08)</td>
<td>0.17</td>
<td>1.03 (0.98–1.07)</td>
<td>0.30</td>
</tr>
</tbody>
</table>

a: Sports and alcohol consumption were entered into the analyses as continuous variables.
attributes, specifically, cognitive hostility accounts for a part of the excess risk as well. In diminishing this excess risk, hostile cognitions in older people might be acknowledged separately and additionally to the risk posed by unhealthy lifestyles.

Conflicts of interest: None declared.

Key points

- Previous studies have shown that hostility, anger and aggression were separately associated with mortality risk in younger populations. Evidence in older populations is scarce, and behavioural pathways explaining this effect seem more dominant among the young.
- The present study shows that cognitive hostility, but not anger, verbal aggression and rebelliousness, is associated with premature mortality in late middle-aged and older people, independent of health behaviours.
- In diminishing this excess risk, hostile cognitions in older people might be acknowledged separately and additionally to the risk posed by unhealthy lifestyles.

References