ORIGINAL ARTICLE

Economic Costs of Neuroticism

A Population-Based Study

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Context: The importance of neuroticism for mental health care use and public health is well established. However, most research has focused on the association between neuroticism and a single specific disorder or health outcome, and the overall effect of neuroticism on use of somatic and mental health care and on society is not clear.

Objective: To examine the economic costs of neuroticism to get an impression of the overall effect of neuroticism on mental health care and on society in general.

Design: Cross-sectional population-based study.

Setting: General population.

Participants: A large representative sample (N = 5504) of the Dutch general population.

Main Outcome Measures: The costs (health service uptake in primary and secondary mental health care, out-of-pocket costs, and production losses) associated with neuroticism.

Results: The total per capita excess costs were $12 362 per year for the reference year 2007 in the 5% highest scorers of neuroticism, $8243 in the 10% highest scorers, and $5572 in the 25% highest scorers. The per capita excess costs of neuroticism are considerably higher than those of mental disorders. The total excess costs of neuroticism per 1 million inhabitants resulting from the 25% highest scorers ($1.393 billion) were approximately 2.5 times as high as the excess costs of common mental disorders ($585 million).

Conclusions: The economic costs of neuroticism are enormous and exceed those of common mental disorders. We should start thinking about interventions that focus not on each of the specific negative outcomes of neuroticism but rather on the starting point itself.

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IT IS WELL ESTABLISHED THAT NEUrotic people are more vulnerable to mental disorders, including depression, anxiety disorders, schizophrenia, eating disorders, and personality disorders.[1-5] Furthermore, neuroticism is related to higher levels of comorbidity,[6] to the onset of comorbidity,[7] and to greater use of mental health services.[8] Neurotic patients more often express medically unfounded somatic complaints,[9,10] and several studies suggest that neuroticism is associated with general health problems, including cardiovascular disease,[11] asthma,[12] and irritable bowel syndrome,[13] even after controlling for depression and other risk factors.[14,15]

Although the term *neuroticism* has its roots in freudian theory, modern definitions of neuroticism are purely descriptive and refer to a tendency to respond with a negative emotional response to threat, frustration, or loss.[8,16,17] Neuroticism is moderately heritable, with genetic factors determining 50% to 60% of their variance,[18,19] and it may reflect much of the genetic vulnerability to mood disorders.[3,20] Some evidence suggests that neuroticism is associated with the serotonin system.[18] Molecular genetic and positron emission tomography studies have associated neuroticism with serotonin receptor polymorphisms and binding,[21,22] and there may be a link between neuroticism and the functional polymorphic variants of the serotonin transporter gene.[23]

Although the importance of neuroticism for public health is doubted by few, the overall effect of neuroticism is not clear. Most research has focused on the association between neuroticism and a single specific disorder or mental health outcome.[8] Although this research suggests that neuroticism has a considerable effect on many aspects of health, these studies do not give a complete indication of the overall effect of neuroticism.

A possible method for assessing the overall effect of neuroticism is to examine its economic costs for society. These

costs are not directly related to 1 specific mental disorder or facet of neuroticism, and they may, therefore, give an impression of the overall effect of neuroticism on mental health care use and on society in general. We examined these costs in a representative, population-based study. The first goal was to calculate the overall economic costs of neuroticism and to compare these costs with those associated with common mental and somatic disorders. The second goal was to examine whether the costs of neuroticism can be attributed to mental and somatic disorders.

METHODS

PARTICIPANTS AND PROCEDURE

We used the data from the Netherlands Mental Health Survey and Incidence Study (NEMESIS), which have been described in detail elsewhere.[24] A random, stratified, multistage sample was obtained in 3 steps at baseline. First, municipalities were stratified by urbanization, and 90 municipalities were drawn randomly and proportionately from these strata. Second, in each municipality, households were randomly drawn from the postal register. Third, in each household, the person with the most recent birthday was selected on the condition that he or she was aged 18 to 65 years and sufficiently fluent in Dutch to be interviewed. Eligible persons who were not immediately available were contacted later in the year. The response rate was 69.7%, resulting in a sample of 7076 people at baseline. The sample followed the same multivariate distribution for age, sex, civil status, and urbanity as the general Dutch population; however, men in the age group 18 to 24 years were slightly underrepresented. All the data were collected in structured face-to-face interviews.

At the first follow-up, which occurred 1 year (mean [SD], 379 [35] days) after baseline measurement, 5618 persons (79.4%) continued their participation. The present study is based on the first follow-up sample because medical consumption and economic costs were measured at that time. In the present study, we want to examine the association between neuroticism, common mental disorders (mood, anxiety, and substance use disorders), and somatic disorders. We excluded 114 individuals with *DSM-III-R* mental disorders with a 1-year prevalence of less than 1% (as measured using the Composite International Diagnostic Interview [CIDI]: schizophrenia, bipolar disorder, obsessive-compulsive disorder, and eating disorder) because the 95% confidence intervals (CIs) around the costs associated with these disorders were very broad. These individuals were excluded regardless of whether they had 1 or more common mental disorders. This resulted in an effective sample size of 5504.

We evaluated the effect of attrition from baseline to follow-up and found that after adjustment for demographic variables, a 12-month mental disorder at baseline only slightly increased the probability of loss to follow-up between baseline and 1-year follow-up (odds ratio, 1.20; 95% CI, 1.04-1.38).[25] Corrective weights were used to improve generalizability.

MEASURES

Neuroticism was assessed using the 14-item version of the neuroticism scale from the Amsterdam Biographic Inventory.[26,27] This questionnaire is based on the Maudsley Personality Inventory[28] and is a much used personality questionnaire in the Netherlands. The internal consistency of this scale was satisfactory (Cronbach α=.80). The correlation with the neuroticism scale of the Revised NEO Personality Inventory,[29] one of the most well-researched personality inventories, is 0.75.[30] It contains items such as "Are you often dissatisfied and grumbling?" "Do you take disappointments so seriously that you cannot get it out of your mind?" and "Do you have the feeling that you are eventually alone in the world?" The scores on the scale range from 0 to 28. To be able to calculate the costs associated with neuroticism, we divided the population into categories of neuroticism. We calculated the economic costs of the 5%, 10%, and 25% highest scorers. To examine the association between level of neuroticism and economic costs further, we also made categories of neuroticism: very low (score of 0-5), mild (score of 6-10), moderate (score of 11-15), high (score of 16-20), and very high (score >20).

The *DSM-III-R* Axis I disorders were assessed using the CIDI,[31] Dutch 2.1 version.[32] The CIDI is a fully computerized psychiatric interview and can be used by trained interviewers who are not physicians. The CIDI is used worldwide, and World Health Organization field trials have documented acceptable reliability and validity.[33-37]

In this study, the following *DSM-III-R* disorders during the past year were examined: major depressive disorder, dysthymia, anxiety disorder (panic disorder with or without agoraphobia, generalized anxiety disorder, simple phobia, social phobia, or agoraphobia without a history of panic), and substance use disorder (abuse or dependence). We also calculated the total number of mental disorders (0, 1, 2, and ≥3).

SOMATIC DISORDERS

From a list of 31 chronic somatic disorders, participants self-reported the presence of 1 or more conditions being treated or monitored by a physician in the 12 months before baseline. Examples included asthma, emphysema, osteoarthritis, heart disease, peptic ulcer, and diabetes. The demographic variables examined included sex, age, educational level, paid job status, and living with a partner or not.

RESOURCE USE AND COSTING

All costs are expressed in US dollars for the reference year 2007. For conversion from euros to US dollars, we used Purchasing Power Parities, which are currency conversion rates that convert currency and equalize the purchasing power of different currencies (see http://www.oecd.org/std/ppp). Because the time frame of this study is restricted to this single year, we did not correct for inflation and did not discount costs. Conceptually, the following types of costs can be distinguished[38,39]: direct medical costs, direct nonmedical costs, and indirect nonmedical costs.

Direct medical costs are the costs of health service resource use. All direct medical costs refer to costs incurred in the mental health care sector in the Netherlands. We also included general practitioner costs and costs of social work and physiotherapy because people with mental health problems often use these services. Information on participants' use of health services was obtained using a prototype version of the Trimbos iMTA Questionnaire for Costs Associated With Psychiatric Illness.[40] This questionnaire registers the number of general practitioner visits, sessions with psychiatrists, etc. In a next step, medical resource use was costed by multiplying the number of health service units (consultations, hospital days, etc) by the full economic unit cost price (obtained from Oostenbrink et al[41]). To these costs we added the costs of pharmacologic interventions as the cost per standard daily dose (obtained from the Pharmaceutical Compass at http://www.fk.cvz.nl), plus 6% value added tax, multiplied by the average number of prescription days, plus the pharmacist's dispensing costs of $7.91 per prescription.

Direct nonmedical costs arise when patients travel to health service providers and pay for parking. In the Netherlands, the av-

erage travel distance between a random address and a general practitioner's practice is 1.8 km. Travel distances to other health services are also known.[41] This information was combined with the information about actual use of health services. Travel distances were valued at $0.17 per kilometer, and 1 hour of parking time was valued at $2.70. To this we added the costs of the patients' time spent in travel, waiting, and treatment at $9.00 per hour. Details of the costs have been presented elsewhere.[38,39]

Indirect nonmedical costs arise when production losses occur due to illness. Participants were asked about the number of days absent from work. These days are divided into workdays (resulting in production losses due to loss of workdays) and days spent in bed while not having to work (resulting in production losses in the domestic sphere). To value a lost day in a paid job, we used the costs that represent the age- and sex-specific monetary value of production losses that occur during absence from work.[42] For persons too ill to perform domestic tasks (with or without a paid job), these costs were valued at the market price of domestic help ($9.00 per hour). The market price is used for these costs because they are assumed to reflect the true costs. All cost calculations were conducted in accordance with the latest Dutch guideline for health economic evaluations,[41] which closely resembles other international guidelines.[43-45]

ANALYSES

First, we examined the associations between levels of neuroticism and demographic variables and the associations between levels of neuroticism and the presence of mental and somatic disorders. These associations were examined using multiple regression analyses (with neuroticism as a continuous variable).

Then we conducted a series of multiple regression analyses to examine the (unadjusted) economic costs of neuroticism. In the first analysis, the overall per capita costs were used as the dependent variable and level of neuroticism was used as the predictor. We conducted separate analyses for the 5%, 10%, and 25% highest scorers and repeated all those analyses for the total, direct medical, direct nonmedical, and indirect nonmedical costs.

To account for initial nonresponse and dropout, corrective weights were used. After weighting, the sample followed exactly the same multivariate distribution for age, sex, civil status, and urbanization as the population according to Statistics Netherlands (downloadable from http://www.cbs.nl).

To account for the possible nonnormality of the cost data, sample errors, 95% CIs, and *P* values were based on 1000 bootstrap replications, and at each bootstrap step, robust sample errors were obtained using the first-order Taylor series linearization method. The latter was performed to obtain correct 95% CIs and *P* values under weighting.

The bootstrap method is often used for getting 95% CIs in economic studies, especially when it is expected that standard statistical theory may not hold, as might have been the case for the nonnormally distributed cost data. For the present data, we found that the bootstrap 95% CIs were nearly identical with the CIs obtained with the help of the robust standard errors (based on the Taylor series linearization method). So, for these data, there is no appreciable difference. Nevertheless, we lend preference to the bootstrap CIs because they are more robust.

Then we used the per capita excess costs to calculate the costs per 1 million inhabitants aged 18 to 65 years. This includes all cost categories (health service uptake, out-of-pocket costs, and production losses) and is equivalent to the per capita excess costs × prevalence × 10^6). For comparative purposes, we also calculated the excess costs of common mental and somatic disorders per 1 million inhabitants aged 18 to 65 years. For these excess costs per 1 million inhabitants, we used the 12-month prevalence rates of mental disorders as reported earlier.[24]

Finally, we examined to what extent the excess costs of neuroticism can be attributed to mental and somatic disorders. We conducted a series of regression analyses with the overall per capita excess costs as the dependent variable, and as predictors we used the different levels of neuroticism, the 3 categories of common mental disorders, and somatic disorders. Then we conducted another series of regression analyses using the overall per capita excess costs as the dependent variable and the levels of neuroticism, common mental disorders, somatic disorders, and demographic variables as predictors. Finally, we repeated these analyses using the same dependent variables and predictors but replaced the variables indicating the common mental disorders with the variables indicating the total number of mental disorders. All the analyses were conducted using a software program (STATA version 8.2/SE for Windows; StataCorp LP, College Station, Texas).

RESULTS

NEUROTICISM IN THE GENERAL POPULATION

Table 1 provides the percentages of people in the general population with varying levels of neuroticism according to different categories of demographic and clinical characteristics. Higher levels of neuroticism are found in women, in people who live alone, in those without a paid job, in those with less education, and in older people. People with higher levels of neuroticism have a mental disorder considerably more often. Among people with the highest 5% neuroticism score, more than 40% have a mood disorder, and more than 60% meet the criteria for any mental disorder in the past year. In this 5% highest scoring category of neuroticism, approximately two-thirds have a somatic disorder compared with 40% in the total general population. Most associations between neuroticism and demographics, mental disorders, and somatic disorders are highly significant ($P < .001$) (Table 1).

PER CAPITA EXCESS COSTS BY LEVEL OF NEUROTICISM

In **Table 2**, total excess per capita costs (unadjusted) are given, as are the direct medical (health service uptake), direct nonmedical (patients' out-of-pocket costs) and indirect nonmedical (production losses stemming from absenteeism) per capita excess costs for the 5% highest scorers for neuroticism. We also present the excess costs for the 10% and 25% highest scorers. The total excess per capita costs of the 5% highest scorers were $12 362. These costs should be interpreted as the excess costs of neuroticism because every person generates, on average, a "base rate" of $3641 annually (unadjusted value), and the additional $12 362 can be uniquely attributed to neuroticism as costs over and above the base rate costs. This base rate (constant in Table 2) is the intercept from the regression analyses, indicating the average costs adjusted for neuroticism. Thus, the actual costs for a person among the 5% highest scorers are $12 362 + $3641 = $16 003 in a given year.

The base rate in Table 2 refers to mean costs in each individual after controlling for the effect of neuroticism. The effect of the 25% highest scorers on this base rate is higher than the 5% highest scorers because this

Table 1. Neuroticism in the General Population: Percentage of People With Differing Levels of Neuroticism[a]

Variable	Total (N=5504)	Neuroticism Scores: 75% Lowest (n=4128)	25% Highest (n=1376)	10% Highest (n=550)	5% Highest (n=275)
Demographic variables, %					
Female	49.1	45.4	63.9	65.9	66.0
Living alone	17.3	14.9	26.8	29.0	33.8
Having a paid job	70.7	73.4	60.1	53.6	48.4
Educational level					
Low	5.4	4.6	8.7	10.5	13.4
Middle-low	34.6	33.7	38.3	41.8	41.6
Middle-high	30.0	31.2	25.1	23.4	23.3
High	29.9	30.5	27.8	24.3	21.6
Age, mean (SD), y	41.05 (11.94)	40.69 (11.83)	42.32 (12.27)	42.97 (12.57)	42.85 (12.04)§
Mood disorder, %	4.8	1.9	16.1	27.2	40.7
Major depressive disorder	4.4	1.8	14.8	24.5	35.8
Dysthymia	1.0	0.3	3.8	7.7	14.0
Anxiety disorder, %	6.3	3.4	17.9	26.8	40.4
Panic disorder±agoraphobia	1.1	0.4	4.0	7.0	13.7
Simple phobia	3.9	2.2	10.6	15.1	24.9
Social phobia	1.8	0.8	5.9	10.8	16.9
Agoraphobia	1.0	0.5	2.8	4.9	6.6
Generalized anxiety disorder	0.4	0.2	1.6	2.9	2.5
Substance use disorder, %	5.0§	4.5	7.1	8.0	10.0
Substance abuse	3.8¶	3.6	4.5	4.5	4.1
Substance dependence	1.2	0.9	2.5	3.5	5.9
Any mental disorder, %	13.8	9.1	32.7	45.8	61.4
No. of mental disorders, %					
1	10.7	7.9	22.1	26.2	28.2
2	1.9	0.9	6.0	10.2	15.0
≥3	1.2	0.3	4.6	9.4	18.3
Somatic disorder, %	39.6	36.8	53.7	61.7	67.0

[a]We tested whether neuroticism differed from the rest of the population using multiple regression analyses (with neuroticism as a continuous variable). All the tests were significant at $P<.001$ except in the cells with § ($P<.05$) and ¶ (not significant).

Table 2. Annual per Capita Costs[a] by Neuroticism Score[b]; Weighted Analysis in 5504 Participants

Variable	Annual per Capita Costs (95% CI), $: Total[c]	Direct Medical	Direct Nonmedical	Indirect Nonmedical
5% Highest				
Neuroticism	12 362 (8697-16 027)	626 (319-933)	411 (56-766)	11 313 (7650-14 975)
Base rate, constant	3641 (3336-3946)	61 (36-86)	39 (24-54)	3542 (3236-3847)
10% Highest				
Neuroticism	8243 (6026-10 459)	531 (244-819)	353 (141-565)	7352 (5283-9422)
Base rate, constant	3447 (3148-3746)	42 (27-57)	26 (16-37)	3379 (3073-3685)
25% Highest				
Neuroticism	5572 (4401-6743)	302 (171-432)	203 (106-301)	5067 (3888-6245)
Base rate, constant	2974 (2688-3261)	23 (16-30)	13 (9-17)	2938 (2662-3215)

Abbreviation: CI, confidence interval.
[a]Costs are the societal costs, including direct medical, direct nonmedical, and indirect nonmedical costs.
[b](Robust) sample errors and 95% CIs are based on 1000 bootstraps.
[c]The sum of the direct medical, direct nonmedical, and indirect nonmedical costs is not exactly the same as the total costs because each type of cost was estimated separately and may vary slightly.

group contains more people despite the higher per capita costs in the 5% highest scorers. The base rate is, therefore, higher in the 5% highest scorers compared with in the 25% highest scorers (Table 2).

The total per capita excess costs were $8243 for the 10% highest scorers and $5572 for the 25% highest scorers. Most of the costs were related to production losses (indirect nonmedical costs).

EXCESS COSTS PER 1 MILLION INHABITANTS

The excess costs of the different levels of neuroticism per 1 million adults are given in **Table 3**. The total (unadjusted) excess costs of the 5% highest scorers on neuroticism are $618.1 million per year per 1 million inhabitants in the age group of 18 to 65 years. Although the per capita excess costs in the 10% highest scorers are lower

Table 3. Annual Costs Attributable to Those With High Neuroticism Scores per 1 Million Inhabitants Aged 18 to 65 Years

Variable	Prevalence	Per Capita Costs, $[a]	Annual Costs per 1 Million Inhabitants, Million $			
			Total	Direct Medical	Direct Nonmedical	Indirect Nonmedical
Neuroticism						
5% Highest scores	0.05	12 362	618.1	31.3	20.55	565.6
10% Highest scores	0.10	8243	824.3	53.2	35.30	735.3
25% Highest scores	0.25	5572	1393.0	75.5	51.00	1270.0
Axis I mental disorders						
Mood disorders	0.048	7851	373.8	31.3	18.9	324.1
Anxiety disorders	0.063	6579	412.5	28.3	21.0	363.0
Substance use disorders	0.050	1858	93.5	10.4	2.7	80.3
Any common mental disorders	0.138	4242	584.8	49.8	29.9	505.6
No. of mental disorders						
1	10.7	1432.0	154.0	10.4	9.2	134.7
2	1.9	8167.0	156.0	19.8	6.6	129.4
≥3	1.2	18 746.0	216.5	14.4	11.3	190.0
Somatic disorder	0.404	4990	2016.0	11.4	9.1	1978.4

[a] These costs are unadjusted.

than those in the 5% highest scorers, the excess costs per 1 million inhabitants are considerably higher ($824.3 million) because the prevalence is twice as high. The excess costs per 1 million inhabitants in the 25% highest scorers are still larger despite the lower per capita excess costs ($1.393 billion per year).

For comparative purposes, we also present the (unadjusted) excess costs of mood disorders, anxiety disorders, substance use–related disorders, and somatic disorders in Table 3. The per capita excess costs of the 5% highest scorers on neuroticism are considerably higher than those of any of the 3 major categories of mental disorders. The per capita excess costs of the 10% highest scorers are also higher than those of the 3 categories of common mental disorders. The 10% highest scorers on neuroticism have approximately the same per capita excess costs as people who have 2 mental disorders at the same time. The excess costs per 1 million inhabitants associated with neuroticism are approximately 2.5 times higher ($1.393 billion per year) than the costs associated with all 3 categories of mental disorders ($585 million per year).

EXCESS COSTS OF NEUROTICISM AFTER ADJUSTMENT FOR SOMATIC AND MENTAL DISORDERS AND DEMOGRAPHICS

To examine whether the excess costs of neuroticism can be attributed to the increased risk of somatic and mental disorders in people with high neuroticism scores, we conducted another series of regression analyses. In these analyses, the per capita costs were entered as the dependent variable, and as predictors we entered neuroticism (high/lower) and the 3 main groups of mental disorders and somatic disorders.

Even after adjustment for mental and somatic disorders, the excess costs of neuroticism are high (**Table 4**). In the 5% highest scorers, the excess costs are still approximately twice as high as those of a mood disorder and of a somatic disorder. In the 10% highest scorers, the excess costs are still higher than those of any other mental or somatic disorder. Only in the 25% highest scorers are the excess costs lower than those of a mood disorder or a somatic disorder but still higher than the excess costs of an anxiety disorder or a substance use disorder.

We also conducted the same analyses with the same dependent variable and predictors but replaced the variables indicating the presence of a mental disorder with variables indicating the number of mental disorders (0, 1, 2, or ≥3 disorders; results are not reported in Table 4). These results indicate that in the 5% highest scorers, the per capita excess costs were higher ($7470) than were the excess costs associated with having 2 mental disorders ($6237) but lower than were the costs associated with having 3 or more mental disorders ($14 257). In the 25% highest scorers, the per capita excess costs ($3696) were higher than having 1 mental disorder ($707) but lower than having 2 ($6478) or 3 or more ($16 036) disorders.

Next, we conducted another series of regression analyses with the per capita excess costs as the dependent variable, and neuroticism, mental disorders, somatic disorders, and demographic variables (sex, living alone, having a paid job, age, and level of education) were entered simultaneously as predictors. As can be seen in Table 4, the results were comparable with those of the earlier analyses. In the 5% highest scorers, the excess costs were still almost twice as high as the costs of a mood disorder or a somatic disorder; the costs in the 10% highest scorers were still higher than the excess costs associated with a mood disorder or a somatic disorder; and the excess costs in the 25% highest scorers were still higher than the costs of an anxiety disorder or a substance use disorder.

For illustrative purposes, we graphically present the per capita excess costs at different levels of neuroticism (very low, mild, moderate, high, and very high) (**Figure**). In participants with a very high level of neuroticism, the per capita excess costs are $22 271, and they decrease steadily with the level of neuroticism (the total excess costs in very low neuroticism are $2797). After adjustment for common mental disorders, the total excess costs

Table 4. Annual per Capita Costs[a] of Neuroticism After Adjustment for Somatic and Common Mental Disorders[b]; Weighted Analysis in 5504 Participants

Variable	Annual per Capita Costs (95% CI), $						
		Adjusted for Mental/Somatic Disorders			Adjusted for Mental/Somatic Disorders and Demographics[c]		
	Unadjusted	5% Highest Scorers	10% Highest Scorers	25% Highest Scorers	5% Highest Scorers	10% Highest Scorers	25% Highest Scorers
Neuroticism							
5% Highest scores	12 362 (8697 to 16 027)	8271 (4483 to 12 058)	NA	NA	7817 (4025 to 11 610)	NA	NA
10% Highest scores	8243 (6026 to 10 459)	NA	5271 (3205 to 7338)	NA	NA	4999 (2878 to 7120)	NA
25% Highest scores	5572 (4401 to 6743)	NA	NA	3612 (2406 to 4819)	NA	NA	3530 (2275 to 4784)
Mental Disorders							
Mood disorders	7851 (5168 to 10 534)	4134 (1828 to 6439)	4404 (2010 to 6799)	4643 (2265 to 7021)	4391 (2041 to 6629)	4655 (2160 to 7151)	4875 (2340 to 7410)
Anxiety disorders	6579 (4349 to 8809)	3328 (1319 to 5338)	3583 (1538 to 5628)	3532 (1334 to 5729)	3073 (986 to 5160)	3679 (1608 to 5751)	3636 (1485 to 5787)
Substance use disorders	1858 (–331 to 4047)	1614 (–428 to 3656)	1646 (–276 to 3568)	1580 (–319 to 3479)	1331 (–545 to 3207)	1297 (–563 to 3156)	1181 (–681 to 3042)
Somatic disorder	4990 (4231 to 5748)	4496 (3772 to 5220)	4447 (3702 to 5191)	4400 (3653 to 5146)	4317 (3555 to 5094)	4287 (3537 to 5037)	4254 (3495 to 5012)
Constant		1560 (1271 to 1850)	1438 (1160 to 1716)	1139 (849 to 1430)	5004 (2110 to 7897)	5023 (2178 to 7869)	4530 (1646 to 7415)

Abbreviations: CI, confidence interval; NA, not applicable.
[a] Costs are the societal costs, including direct medical, direct nonmedical, and indirect nonmedical costs.
[b] (Robust) sample errors and 95% CIs are based on 1000 bootstraps.
[c] Demographic variables entered were sex, living alone, having a paid job, age, and level of education.

have a similar pattern ranging from $15 534 in the highest category of neuroticism to $857 in the lowest category. We also present the direct medical excess costs in the Figure. As can be seen, the pattern of these costs is comparable with that of the total excess costs.

COMMENT

We found that the economic costs of neuroticism exceed those of common mental disorders and those of somatic disorders. The 5% highest scorers cost more than 1.5 times as much as a mood disorder, the most expensive of the 3 major categories of common mental disorders, and approximately 3 times as much as a somatic disorder. The 10% highest scorers on neuroticism still cost more than a mood disorder and almost twice as much as a somatic disorder. At the population level, the excess costs of the 25% highest scorers were almost $1.4 billion per 1 million inhabitants, which is approximately 2.5 times as high as the total costs of common mental disorders (almost $600 million per 1 million inhabitants) and approximately two-thirds the costs of somatic disorders.

Earlier research has focused on the association between neuroticism and specific disorders or health outcomes. These studies give only a partial picture of the overall effect of neuroticism. The present study shows that the effect of neuroticism on mental health care and population health is enormous and that the associated economic costs exceed those of common mental disorders by far.

Neuroticism is not a fixed characteristic but varies from zero to severe on a continuous scale. In the present study, we examined the 5%, 10%, and 25% highest scorers on neuroticism. These thresholds are admittedly arbitrary and could be easily replaced by other thresholds. The results of this study show that there is a continuously increasing relationship between the economic costs and level of neuroticism ranging from low per capita costs in the lowest level of neuroticism (<$3000) to very high costs in the highest level of neuroticism (>$22 000).

The costs of neuroticism are not limited to the costs associated with common mental disorders and somatic disorders. Although there is a clear association between neuroticism and these disorders, the excess costs of neuroticism are still very high after adjustment for these disorders. This should not come as a surprise because neuroticism has been found to be associated with many other mental disorders, including personality disorders and somatoform disorders.[5]

The strengths of this study include the relatively large, representative community sample (N = 5504), the inclusion of direct medical and nonmedical costs, as well as indirect nonmedical costs, and the use of well-validated diagnostic instruments to assess the presence of mental disorders. There are, however, also some limitations. First, although the number of participants was large, it was relatively small for economic studies,[46] which resulted in large standard errors and CIs. Second, we used data from the second measurement wave of the NEMESIS; at this measurement point, some attrition had taken place that may have distorted the results. However, corrective weights were used to control for selective dropout. A third limitation is that we collected economic data associated with

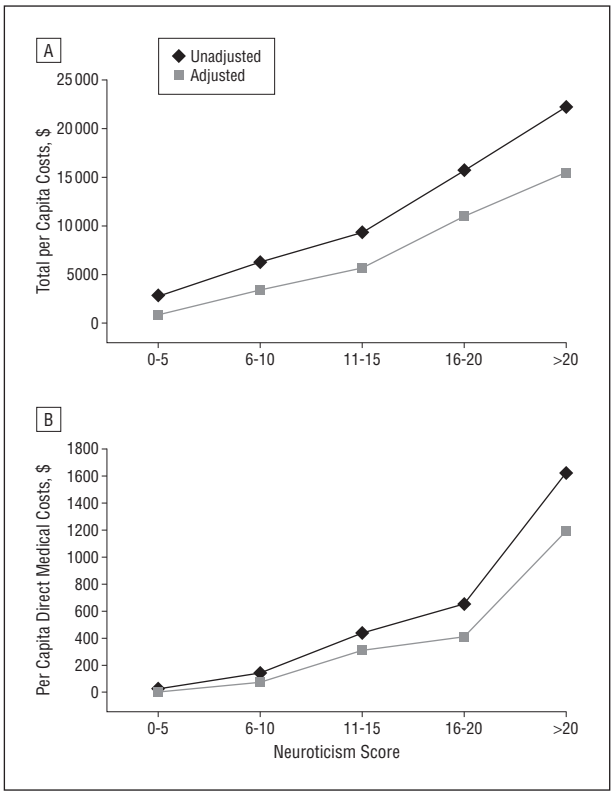

Figure. Total (A) and direct medical (B) annual per capita costs across levels of neuroticism in the general population. The adjusted values are adjusted for mood disorders, anxiety disorders, substance use disorders, and somatic disorders.

mental health and did not include all health care costs associated with somatic disorders but only those costs resulting from the use of mental health services, primary medical care, social work, and physiotherapy. This underestimates the total costs for somatic disorders. However, if we would have been able to examine specialty medical care and surgery, it is possible that an even stronger picture would have emerged because it is likely that highly neurotic persons use these high-cost specialty services at high rates. Also, the NEMESIS data do not allow estimation of the costs stemming from being less productive while at work ("presenteeism" as opposed to "absenteeism"). The literature shows that the costs due to presenteeism can be substantial.[47] Another important limitation is that medical consumption and absenteeism due to mental and somatic disorders largely depend on the way health care is organized in a particular country and its social security system. Therefore, costs differ largely across countries, and it is not possible to generalize the results of this study directly to another country. Although the costs in this study are calculated for the Netherlands, it does seem probable that neuroticism also plays a highly important role in the costs of health care systems in other Western countries.

We also remind the reader that this study has not established a causal association between neuroticism and mental health care costs. There are several possible pathways through which neuroticism may have an effect on economic costs. First, there could be an indirect effect in which neuroticism causes or increases the risk of making economic costs. Because we have not assessed all mental and somatic disorders in this study, it is possible that if every mental disorder had been assessed, the costs of discrete mental disorders would equal that associated with high neuroticism. But, it is also possible that there is a direct effect of neuroticism on the economic costs. In this case, people scoring high on neuroticism would, for example, be more inclined to seek help for problems or disorders than other people. To establish a causal association between neuroticism and mental health care costs, a longitudinal design would have been more appropriate.

Can neuroticism be used as a starting point for the development of new interventions for prevention and treatment? Because neuroticism is a personality characteristic, it is relatively stable, although there are indications that personality can change to a certain extent during the life course.[48,49] Some indications suggest that selective serotonin reuptake inhibitors may reduce the level of neuroticism in depressed patients.[18,50] However, it should not be expected that current treatments can cure or substantially reduce neuroticism. Given the stability of this personality trait, the high heritability, and the likely gene-environment correlations operating for this trait, it is unlikely that treatment will be achieved easily.

On the other hand, we should not be too pessimistic about interventions to reduce mental health problems associated with neuroticism. Whether interventions aimed at neuroticism and the prevention of mental health problems are effective is an empirical question, and randomized trials should be conducted to test the hypothesis of a causal association between neuroticism and mental health and to evaluate the malleability of neuroticism.

There is no doubt that the effect of neuroticism on individuals and on public health is considerable, and we showed that it is also associated with enormous economic costs. Perhaps we should start thinking about interventions that focus not on each of the specific negative outcomes of neuroticism but rather on the starting point itself.

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