Psychiatria Danubina, 2012; Vol. 24, No. 1, pp 66-72 *Original paper*

CAN THE BIG FIVE FACTORS OF PERSONALITY PREDICT LYMPHOCYTE COUNTS?

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received: 16.7.2011; revised: 18.10.2011; accepted: 16.12.2011

SUMMARY

Background: *Psychological stress is known to affect the immune system. The Limbic Hypothalamic Pituitary Adrenal (LHPA) axis has been identified as the principal path of the bidirectional communication between the immune system and the central nervous system with significant psychological activators. Personality traits acted as moderators of the relationship between life conflicts and psychological distress. This study focuses on the relationship between the Big Five factors of personality and immune regulation as indicated by Lymphocyte counts.*

Subjects and methods: *Our study included 32 professional soldiers from the Slovenian Army that completed the Big Five questionnaire (Goldberg IPIP-300). We also assessed their white blood cell counts with a detailed lymphocyte analysis using flow cytometry. The correlations between personality variables and immune system parameters were calculated. Furthermore, regression analyses were performed using personality variables as predictors and immune parameters as criteria.*

Results: *The results demonstrated that the model using the Big Five factors as predictors of Lymphocyte counts is significant in predicting the variance in NK and B cell counts. Agreeableness showed the strongest predictive function.*

Conclusions: *The results offer support for the theoretical models that stressed the essential links between personality and immune regulation. Further studies with larger samples examining the Big five factors and immune system parameters are needed.*

Key words: *Big Five factors - Lymphocyte counts – military - psychoneuroimmunology*

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INTRODUCTION

Psychoneuroimmunology has a relatively short history. It emerged as a new field of scientific research after Ader and Cohen (1975) showed that immune system functions can be conditioned. Today it is well known that psychological stress has effects on the immune system, which can result in increased susceptibility to various infections, latent virus reactivation, and also influence immunoregulatory circuits (Marshall 2011). The principal path of the communication between the immune system and the central nervous system has been linked to the HPA axis, which can also be influenced by psychological factors (Keller, Schleifer, Bartlett, Shiflett & Rameshwar 2000). Studies associated personality characteristics such as aggression and hostility as some of the variables that can affect the activity and number of lymphocyte populations (Granger, Booth & Johnson 2000, Christensen et al. 1996). Lymphocyte cell counts and activity are important in the individuals' competence for protection from a wide range of immunological threats (Vaz-Leal, Rodriguez-Santos, Melero-Ruiz, Ramos-Fuentes & Garcia-Herráiz 2010). Considerable attention has been devoted to personality traits as moderators of the relationship between life conflicts and psychological distress (Bolger & Zuckerman 1995, Holahan & Moos 1986). However, up until now less research has been conducted in regard to the possible connections of personality dimensions and the parameters of the immune system.

The five factor model (FFM) is widely accepted as the most salient taxonomy of the basic personality structure (McCrae & Costa 1997). According to this model, the interpersonal variance in personality traits is best explained by five major personality dimensions labeled as the Big Five: Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience. We were able to find only two studies examining the role of immune parameters in connection with the Big Five. Segerstrom, Castaneda & Spencer (2003) used the five factor model of personality to evaluate effects of optimism on immunity. They found that only Conscientiousness had an effect on the parameters of the immune system, measured by the DTH (delayed-type hypersensitivity) response. Furthermore childhood conscientiousness was related to health outcomes and longevity, possibly because it relates to executive functioning including aspects of impulse control and planning (Friedman, Tucker, Tomlinson-Keasey, Schwartz, Wingard & Criqui 1993, Kern, Friedman, Martin, Reynolds & Luong 2009). A study by Miller, Cohen, Rabin, Skoner & Doyle (1999) examined three dimensions of the five factor model (Extraversion, Agreeableness and Neuroticism) and found no differences in leukocyte subsets for any of the dimensions. Individuals with low levels of extraversion had higher basal natural killer cell activity but not natural killer cell counts.

The current study focuses on the relationship between the Big Five and lymphocyte subset measures of the immune system function. As indicated by previous research at least some of the Big Five could be connected with the measures of the immune system. Especially, we could predict substantial correlations with immune system measures for Conscientiousness on the basis of the Segerstrom et al. (2003) study, and for Neuroticism because of its known relatedness to distress (Rantanen et al. 2005) and coping (Penley & Tomaka 2002). Further, we may also expect the connections between Agreeableness and lymphocyte measures, according to the studies that stressed the role of this personality factor in risk, stress, and burnout management (Cano-Garcia et al. 2005), and in the activation of the autonomous nervous system (Miller et al. 1999). Consequently we can also assume that the Big Five could have an essential predictive function in relation to the immune system parameters.

SUBJECTS AND METHODS

Participants and procedure

The study was performed as a research project of the Slovenian Ministry of Defense. It was approved by the Slovenian Medical Research Ethics Committee and informed consent was obtained.

Data for the study were collected from 32 participants who were all professional soldiers employed in the Slovenian Army and were chosen (after medical, physical and psychological examinations) to participate in a foreign country mission.

The inclusion criteria were: professional member of the military, only soldiers that were dislocated to a military camp and undergoing their preparation for a mission in a foreign country were chosen.

The exclusion criteria were: any condition that could affect the immune system, abnormal CRP (>8 mg/L) or sedimentation rate (normal value established according to age and sex).

Therefore all participants had a similar food regime and involvement in physical exercise, and they underwent extensive medical check-up by specialists in occupational medicine and internal medicine according to the general foreign mission military protocol.

Among them, there were 31 males and 1 female with the average age of 30.1 years (SD=6.7) and an average education of 12.3 years (SD=1.7). All participants completed personality and optimism questionnaire booklets. In addition immunological tests were collected in a separate session on the same day as the personality assessment.

Measures

International Personality Item Pool (IPIP) – IPIP-300 Version.

We used the Slovenian translation of the International Personality Item Pool (IPIP) developed by Goldberg (Goldberg 1999) for assessing personality dimensions in the sample. The IPIP-300 is a broad-bandwidth, public domain personality inventory that measures the Big Five factors (Extraversion, Agreeableness, Conscientiousness, Neuroticism, and Openness to Experience) and their facets (six for each factor). It contains 300 items, 60 for each FFM factor with corresponding facets. The participants used a 5-point scale ranging from 1 (very inaccurate) to 5 (very accurate) to obtain the scores for factor dimensions and facets. Each factor was scored in such a way that higher numbers indicated greater quantities of the trait. The original IPIP-300 has good metric characteristics as reported by Goldberg (1999, International Personality Item Pool 2001). The Slovenian version has been adopted by the translation-retranslation procedure. It also has good metric characteristics. In the original Slovenian standardization sample (N=185), Cronbach alpha coefficients range from 0.88 to 0.94 for the factor scales, and from 0.59 to .89 for the facet scales.

Life Orientation Test – Revised

We also used a Slovenian translation of the Dispositional Optimism: Life Orientation Test—Revised (LOT-R) (Scheier 1994). LOT-R, the revised version of the LOT, was developed to reduce item overlap between the LOT and measures of coping through positive reinterpretation. LOT-R is comprised of 10 items rated on a 5-point scale ranging from 1 (I agree a lot) to 5 (I disagree a lot). Six items are true measure of optimism (3 positively and 3 negatively phrased), an additional four items are fillers. Confirmatory factor analysis (CFA, (Sorbom & Joreskog 1981) of six optimism items confirmed one-dimensional structure of LOT-R (Chi-Square=6.81; p=0.56; RMSEA=0.00). Cronbach alpha coefficient for LOT-R items in this sample is 0.683.

Immunological assessment

Peripheral human blood leucocytes were collected by the venepuncture procedure and placed into EDTA Vacutainers (Becton Dickinson, Mountain View, CA). The samples (100 µl of blood) were incubated with 10 µl of the appropriate MoAb for 15 to 30 min at room temperature in a dark place then washed twice with cold PBS buffer (Becton Dickinson). Red blood cells were eliminated by adding 2 ml of lysing solution PBS, mixed and centrifuged 5 min at 1600/min. The supernatant was removed and 1 ml PBS was added again. The samples were then ready for flow-cytometric analysis. As a rule analyses were completed within 24 h. If analysis was not performed immediately, the closed test tubes were stored at 4°C in a dark place.

All monoclonal antibodies (MoAb) were labeled directly either with fluorescein isothiocyanate or phycoerythrin. Antibodies against the following cell surface structures were applied: CD3, CD4, CD8, CD19, HLA-DR, NK CD14/CD56 (Becton Dickinson,

Mountain View, CA). Two-parameter analysis was performed to determine the proportion of T cells (CD3+), T helper cells (CD3+CD4+) and cytotoxic T cells (CD3+CD8+). Isotype controls (Becton Dickinson, Mountain View, CA) and a control of viable cells (LIVE/DEAD kit, Molecular Probes, OR) were included. At least 2000 gated viable cells were analyzed for each test, and signals from two light scatters and four fluorescence parameters were analyzed with the Becton Dickinson Lysis II software.

Statistical analysis

The data obtained in this study have been analyzed in two steps. First, the correlations between personality variables and immune system parameters were calculated. The Bonferroni correction was taken into the account for the interpretation due to multiple correlations used. We calculated that the significance level for the correlations is $p<0.001424$.

Afterwards, four regression analyses were performed using personality variables as predictors and immune parameters as criteria. The α error rate was divided by the number of regression analysis according to the Bonferroni correction due to the use of multiple analyses. Therefore the α error rate used for interpreting the regression models was 0.0127.

Statistical analyses of personality and immunological data were performed using the Statistical Package for Social Sciences (SPSS Version 13).

RESULTS

Descriptive statistics

We calculated the descriptive statistics and normality tests for all the variables involved in the study (Table 1).

Correlations

The correlations between personality traits and optimism with the immune values were established. We included a correction for multiple testing described under Analysis in the Methods section (Table 2).

After the level of significance was corrected for multiple testing none of the results reached statistical significance. If we examine the tendencies in the results nevertheless we can see that Agreeableness has higher correlations with immune parameters than other personality factors. Its highest positive correlations are with Lymphocyte count, T Lymphocyte count as well as NK cells count. Conscientiousness shows positive association with both T Lymphocyte count and cytotoxic Lymphocyte count. Optimism shows highest positive associations with NK cells parameters.

Regression effects of personality on immune parameters

Four regression analyses were used to predict the dependent variables (a) Lymphocyte count, (b) B Lymphocyte count, (c) T Lymphocyte count and (d) NK cells count. In each equation all five factors of personality were inserted using the Enter method, in which all predictors are entered in a single step. In this way all predictors are taken into equation even if the probability of F is too high (much of variation of the dependent variable remains unexplained). The purpose of this was to see the comparative prediction strength of all five factors of personality. Table 3 shows regression results for Lymphocyte counts.

All five personality factors explain substantial percentages of variance of Lymphocyte count (from 0.362 for T Lymphoctye to 0.633 for NK cell count). However, the model with personality factors as predictors was statistically significant only in predicting

Table 1. Descriptive statistics for all personality and immunological variables

Variables	Statistics									
	N	Minimum	Maximum	M	SD	Kurtosis	SE_{sp}	Skewness	SE_{as}	Normal-distrib.
Extraversion	32	142	248	211.5	20.04	3.39	0.81	-1.10	0.41	yes
Agreeableness	32	180	262	222.5	18.31	0.28	0.81	0.19	0.41	yes
Conscientiousness	32	190	277	231.3	19.89	0.46	0.81	0.22	0.41	yes
Neuroticism	32	79	188	136.2	24.24	0.57	0.81	0.17	0.41	yes
Openness	32	159	234	191.2	20.86	-0.53	0.81	0.39	0.41	yes
Optimism (LOT-R)	32	16	29	22.9	3.56	-0.63	0.81	0.16	0.41	yes
Lymphocyte (cells/l)	32	0.20	3.20	2.04	0.56	2.73	0.81	-0.64	0.41	yes
T Lymphocyte (cells/l)	32	0.98	2.19	1.55	0.30	-0.27	0.81	0.15	0.41	yes
B Lymphocyte (cells/l)	32	0.07	0.49	0.23	0.09	0.76	0.81	0.73	0.41	yes
T-helper (cells/l)	32	0.48	1.17	0.77	0.19	-0.59	0.81	0.29	0.41	yes
Cytotoxic lymphocyte (cells/l)	32	0.26	0.95	0.53	0.18	0.67	0.81	1.01	0.41	no
NK cells (cells/l)	32	0.08	0.91	0.31	0.18	4.01	0.81	1.79	0.41	no

Normality of distribution was measured with Kolmogorov Smirnov test, yes – distribution is normal, no - distribution is not normal ($p<0.05$).

Table 2. Spearman Rho and Pearson r coefficient of correlation between personality variables and immune parameters

Immune parameters	Personality variables (Big Five factors and Optimism)					
	Extra version	Agree ableness	Conscien-tiousness	Neuro ticism	Openness	Optimism
Lymphocyte (cells/l)	0.038	0.533	0.311	-0.084	0.058	0.260
T Lymphocyte (cells/l)	-0.028	0.423	0.398	-0.150	-0.033	0.001
B Lymphocyte (cells/l)	0.090	0.273	0.184	0.172	-0.081	0.149
T-helper (cells/l)	0.036	0.107	0.249	-0.211	-0.016	0.058
Cytotoxic lymphocyte (cells/l) [a]	-0.212	0.099	0.374	-0.084	0.190	-0.090
NK cells [a] (cells/l)	0.301	0.481	0.226	-0.049	0.289	0.375

[a] Spearman Rho was calculated instead of Pearson r

Table 3. Regression model summary for predictors five factors of personality, standardized Beta coefficients for individual predictors and their significance

Dependent variable	Standardized Beta coefficients and significance for individual predictors										ANOVA summary
	Extraversion		Agreeableness		Conscientiousness		Neuroticism		Openness		R^2, F, significance
Count	Beta	p	Beta	p	Beta	p	Beta	p	Beta	p	
Lymphocyte	-0.098	0.633	0.737	0.004(*)	0.126	0.660	0.284	0.250	-0.254	0.179	R^2=0.389, F(5,31)=3.315, P=0.019
T Lymphocyte	-0.225	0.302	0.398	0.109	0.550	0.071	0.276	0.298	-0.313	0.118	R^2=0.362, F(5,30)=2.840, P=0.036
B Lymphocyte	0.335	0.105	0.438	0.061	0.520	0.068	0.916	0.001(*)	-0.487	0.012(*)	R^2=0.442, F(5,30)=3.968, P=0.009(*)
NK cells	0.248	0.137	0.951	0.000(*)	-0.167	0.458	0.481	0.220	-0.024	0.868	R^2=0.633, F(5,30)=8.642, P=0.000(*)

(*) significant at p<0.0127 according to the Bonferroni correction

B Lymphocyte and NK cell counts. Furthermore, the Agreeableness factor was the only significant predictor of Lymphocyte and NK cell count, while Neuroticism and Openness significantly predicted the B Lymphocyte count, and no single personality factor contributed significantly to the prediction of T Lymphocyte count (Conscientiousness being the highest predictor in this case). Somewhat surprisingly Neuroticism turned out to be the most significant positive predictor of B Lymphocyte count although the correlation was not statistically significant. Apparently the collateral correlations with other predictors increased the effect of Neuroticism dimension in regression analysis. Again, in the additional analyses we did not find any significant effect of Optimism beyond the effects of the Big Five Factors.

As expected already on the basis of previous correlation analysis, Agreeableness is the strongest predictor among personality variables. Computing the multiple correlations between variables shown in Table 3 in the reverse manner, the by far highest R Square between four immune parameters and single personality factor was obtained for Agreeableness (0.504), the others being far lower (0.224 for Openness, 0.188 for Conscientiousness, 0.93 for Extraversion, and Neuroticism). We may thus conclude that the individuals in our sample high on Agreeableness had higher Lymphocyte count. A similar, but much weaker connection with Lymphocyte count parameters is discernible also for the other four personality factors.

DISCUSSION

In our study we focused on the connection between personality factors and enumerative aspects of lymphocyte subpopulations. The results of the study suggest that the Big five factors can predict B Lymphocyte and NK cell counts. Somewhat unexpectedly our results showed that Agreeableness was the most important predictive factor, and not Conscientiousness as previously hypothesized. The possible link between Agreeableness and immune function may be elucidated by the fact that both are associated with the quality of social relationships. More agreeable persons enjoy more social support which in turn increases their immunological effectiveness. We may further speculate that Agreeableness is a desired trait in military personnel. Individuals high on Agreeableness are altruistic, emphatic, cooperative, moral and trusting, all of which represent qualities that are important in teamwork (Lim & Ployhart 2004). Therefore soldiers who are low on this trait might experience more stress

and less support from colleagues and superiors. In stress research, Agreeableness was found to be the main protective factor (when highly expressed) and main risk factor (when it is low) for burnout (Cano-Garcia et al. 2005). Furthermore it is possible that Agreeableness is connected with sympathetic nervous system activity. Miller (1999) found that individuals with low Agreeableness tended to have higher blood pressure and epinephrine. These findings suggest that low agreeable individuals tend towards a chronic activation of SAM axis, which leads to increased catecholamine production and in turn suppresses the immune functions, since it is hypothesized that chronic secretion of catecholamines downregulates glucocorticoid receptor expression (Miller, Cohen & Ritchey 2002). Contrary to our hypothesis we found no correlations between Neuroticism and Lymphocyte counts. Although Miller (1999) did find higher cortisol levels he did not obtain any differences in white blood counts in individuals with high Neuroticism. He concluded that individuals with high Neuroticism often report somatic complaints but have no physiological, objective basis for them. One could speculate that, although Neuroticism is connected with higher distress (Rantanen et al. 2003) it is more an indicator of heightened sensibility than a predictor of objective differences in health status.

In our study, Conscientiousness did not correlate significantly with Lymphocyte or Lymphocyte subpopulation counts. The only prior study addressing the connection of the Conscientiousness trait with immune parameters found that Conscientiousness has an effect on DTH response due to the association of this trait to optimism (Segerstrom et al. 2003). A number of other studies suggested that optimism is related to immune parameters (Cohen et al. 1999, Segerstrom 2001, Segerstrom, Taylor, Kemeny & Fahey 1998), depending on the type of the stressors involved. We also calculated the partial correlations between the Big five and immune parameters with optimism as a controlling variable. The partialization further reduced the significance of the correlations but the majority of correlations remained essentially unchanged if compared with normal non-partialized correlations. It seems therefore that the moderating effect of optimism is not very strong in our case. Nevertheless, Optimism has connections to Agreeableness (0.627) and Neuroticism (-0.536) that remain significant even after the correction for multiple testing.

The results of regression analyses revealed a possible role of the Big five factors in predicting Lymphocyte count and thus partially confirmed our last hypothesis. The Big five factors explained 0.442% of variance in B Lymphocyte count and 0.633% of variance in NK cells count. Reports show that reduction of T Lymphocyte is connected with an increased risk of inflammation (Colonna-Romano et al. 2004), while the reduction in B Lymphocyte counts affects humoral immunity and reduces the protective function of antibodies (Linton & Dorshkind 2004). It is therefore interesting to note that certain personality factors can be associated with increased Lymphocyte count.

Looking at the facets of each personality dimension we found that on the whole, the facets do not contribute substantially beyond the effects of unique factors to the explanation of the variance in the Lymphocyte counts. The exception is the domain of extraversion with a very significant incremental effect of the facets over the unique factor effect. The facets of extraversion correlate with Lymphocyte count significantly more than the Extraversion factor alone (R=0.635 compared with 0.389, the change being significant on .02 level). However, this increment is due almost exclusively to the effects of two extraversion facets, stimulation seeking (beta =-0.544), and joyfulness (beta =0.619). It is interesting that both components of extraversion associate with Lymphocyte count in opposite directions despite their quite substantial mutual correlation (0.596).

There are several possible interpretations of how personality factors and Lymphocyte counts could be related. As already mentioned, the personality dimensions have influence on stress behavior, and may consequently affect the functioning of the immune system (and vice versa) in its entire neuroendocrine context. Solomon and Moos (1964) wrote about the influence of stress and emotions on adrenal cortical steroid hormones 40 years ago. However, it is questionable whether the general explanatory model linking psychological factors to neuroendocrine responses to stress by HPA axis activation (Hurwitz & Morgenstern 2001) could explain all the variance in blood cell count associated with personality factors. Some other sources of personality – immune system correlations must be taken into consideration as well. In addition the possibility of the vice versa effect (the immune system factors influencing personality) should be considered similarly to the process seen in long-term sickness behavior (Viljoen & Panzer 2005).

First, we may devote attention to the genetic factors. Both personality and immune system factors are genetically determined (Petitto et al. 1999, Jang, Livesley, Angleitner, Riemann & Vernon 2002, McCrae et al. 2002), and a possible genetic relation between them seems possible. As was shown by Petito et al. (1999) there is some evidence for a linkage between the genetic basis of certain behavioral traits and NK cell activity. Genetic linkage or pleiotropic gene effects could be a potential way of explaining the association of the five personality factors and immunological traits in the future.

Both personality dimensions and immune function are related to the activity of the most investigated neurotransmitter systems in the brain, especially noradrenergic, cholinergic, serotonergic, and dopaminergic systems (Depue & Colline 1999). However, the personality – immune system interactions on the

neurotransmitter level are not sufficiently clarified to offer definite answers at this moment.

Differences in affect and optimism are related both with personality dimensions and immunological regulation and can therefore contribute to the general relationship between personality and the immune system (Segerstrom et al. 2003, Segerstrom 2001, Segerstrom et al. 1998). The decline in NK activity in response to stress has been associated with greater negative affect (Kiecolt-Glaser et al. 2002) and with the right-prefrontal activation, which is in turn associated with negative emotionality (Davidson, Coe, Dolski & Donzella 1999, Davidson, Jackson, & Kalin 2000). Personal relationships, especially social support, are also linked with immune function (Ader & Cohen 1975, Uchino, Cacioppo & Kiecolt-Glaser 1996). Thus, in further research, the role of emotionality and social support as possible mediators of personality – immune system relations should be more thoroughly clarified. On the whole, the results of our study offer some support for the theoretical models that stressed the role of personality factors in the activity of the immune system but further research is needed (Kiecolt-Glaser et al. 2002, Bolger & Zuckerman 1995, Segerstrom et al. 2003, Segerstrom 2001, Segerstrom et al. 1998).

Our study has several methodological limitations the most important of them is the small number of participants. None of the correlations were high enough to reach statistical significance after the corrections for multiple testing were made. It is therefore premature to generalize the tendencies we found. In addition, quantitative measures of the immune system parameters (such as Lymphocyte counts) might not be the best way of assessing the immune status. Qualitative measures (such as DTH response) are clinically more relevant (Segerstrom, Castaneda & Spencer 2003).

Furthermore, the military sample used in this study has its own characteristics and it would be necessary to repeat such findings on a larger sample from the general population. On the other hand it is not often that we find a sample of individuals with the same food and exercise regime. In this regard military personnel are an interesting subgroup for research in psychoneuroimmunology.

CONCLUSIONS

Our findings imply the need for more detailed research of the connections of personality dimensions with immunological parameters. It also seems wise to include the measurement of the hormonal levels into the methodological design of this research. We suggest that more attention to personality factors with their genetic and neurohormonal basis may enrich the future psychoneuroimmunological research and possibly open new ways for medical, psychological and other interventions and applications.

Acknowledgements

The study was performed as a research project of the Slovenian Ministry of Defense.

Conflict of interest: None to declare.

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