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Research article

Nonproductive thoughts, somatic symptoms and well-being in adolescence: testing the moderator role of age and gender in a representative study

Natália Kocsel [a,*], Zsolt Horváth [a,b], Melinda Reinhardt [a,f], Edina Szabó [a,e], Gyöngyi Kökönyei [a,c,d]

[a] Institute of Psychology, Faculty of Education and Psychology, ELTE Eötvös Loránd University, Budapest, Hungary
[b] Doctoral School of Psychology, ELTE Eötvös Loránd University, Budapest, Hungary
[c] SE-NAP2 Genetic Brain Imaging Migraine Research Group, Hungarian Academy of Sciences, Semmelweis University, Budapest, Hungary
[d] Department of Pharmacodynamics, Faculty of Pharmacy, Semmelweis University, Budapest, Hungary
[e] Center for Pain and the Brain, Department of Anesthesiology, Critical Care and Pain Medicine, Boston Children's Hospital, Harvard Medical School, United States
[f] XIV. District Medical Center, Child and Adolescent Psychiatry, Budapest, Hungary

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ABSTRACT

Background: Previous findings suggest a female preponderance in nonproductive thoughts -rumination and worry-, but studies on gender differences in the strength of the relationship between nonproductive thoughts, somatic symptoms and subjective well-being are scarce. Our aim was to test whether gender and age would moderate these associations.

Methods: 1572 adolescents were involved in this representative cross-sectional study (770 boys; mean age = 15.39; SD = 2.26 years). Nonproductive thoughts were measured by Nonproductive Thoughts Questionnaire for Children (NPTQ-C), somatic symptoms were assessed by Somatic Complaint List (SCL), while Mental Health Continuum-Short Form (MHC-SF) was used to measure subjective well-being. To assess the moderation effects of age and gender on the relationship between nonproductive thoughts, somatic symptoms and well-being, four multiple indicator multiple causes (MIMIC) models were defined.

Results: Our results suggested that higher rates of nonproductive thoughts predicted a higher level of somatic symptoms and a lower level of subjective well-being. The analyses revealed that although nonproductive thoughts were strongly and equally associated with somatic symptoms among boys and girls, age was a significant moderator. Gender also moderated the relationship between nonproductive thoughts and subjective well-being.

Conclusions: Our results support the importance of nonproductive thoughts in somatic symptoms and highlight that the strength of the relationship is similar across both genders but could be dependent upon age. The findings also shed light on the decreased well-being of girls, especially with elevated level of nonproductive thoughts.

1. Introduction

Rumination and worry are considered the unconstructive and maladaptive forms of the repetitive thinking process. According to Watkins (2008) there are three properties by which we could differentiate between the unconstructive and constructive forms of thoughts. If the valence of the thoughts is negative; if the thoughts appear in a negative intrapersonal and situational context; and if the thoughts reflect an abstract level of processing (i.e., the desirability of a certain outcome is more important than its feasibility), we could identify them as nonproductive. Since rumination and worry meet these criteria, they could be discussed together, under the umbrella term of nonproductive thoughts [1]. Despite the fact that rumination and worry are often studied separately [2, 3, 4], they share many common elements such as self-focused perspective, repetitiveness, or intrusiveness. In addition, both rumination and worry play important, (partially) overlapping roles not just in the development and maintenance of major depressive disorder or generalized anxiety disorder [5, 6, 7, 8], but in many other psychopathologies as well [9, 10], highlighting their role as transdiagnostic proximal risk factors [11]. Based on their similar features, and their role in several mental disorders among adults and adolescents as well [8, 11], in the present manuscript we refer to rumination and worry together, as nonproductive thoughts.

Previous studies have found that nonproductive thoughts, especially rumination significantly predicts the development of internalizing psychopathology (especially depression) of school-aged youth, which

* Corresponding author.
E-mail address: kocsel.natalia@ppk.elte.hu (N. Kocsel).

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indicates that it is particularly important to investigate these repetitive thoughts among adolescents [12, 13, 14, 15]. The transition from childhood to adulthood is a sensitive developmental phase as adolescents face many biological, behavioral and social challenges [16, 17] which are intertwined with low emotional and cognitive regulation due to the immature prefrontal areas [18, 19]. Previous studies also suggested that there is a critical phase around the age of 14 or 15 (at least in western cultures), when there is an increase in health risk behaviors, such as psychoactive substance use, smoking or alcohol consumption [20], and more severe depressive symptoms [14, 21].

Accumulated evidence indicates [14, 22] that adolescent girls have higher rates of depressive symptoms than boys. Similar gender differences were detected in nonproductive thoughts as well [15, 23], among second-grade children [24] and 12-year-old (pre)adolescents [25]. This provides a putative explanation for gender differences in depression.

Previous longitudinal studies have pointed out that although the predictors (i.e., rumination) of depression are similar for both genders [26] the relationship between rumination and depression may differ between genders. According to some results girls are more likely to carry risk factors for depression such as more ruminative self-focused style of responding, socially oriented, cooperative interaction style etc., which might interact with the increased social and biological challenges of early adolescence to make adolescent girls more prone to depression than boys [21]. However, we do not know whether the association between nonproductive thoughts and depression is stronger among adolescent girls than in boys, since formal statistical tests for this are usually missing. Padilla Paredes and Calvete Zumalde (2015) also found it was mainly in girls that brooding, the maladaptive and passive form of rumination, acted as a risk factor for depression [27]. In line with these findings, significant gender × rumination interaction was found in another longitudinal study, indicating that although adolescent girls did not differ from boys in their initial levels of rumination or depressive symptoms, rumination had a stronger effect on depression level half a year later for girls than for boys, even after controlling for age [28].

These findings raise the possibility that the strength of the relationship between nonproductive thoughts and psychopathology is not invariant across genders, although these interactions have not been analyzed in depth. Therefore, it remains to be seen whether the extent of these differences between boys and girls is statistically significant.

Furthermore, most researchers have focused on the effects of nonproductive thoughts (worry and rumination) on psychiatric disorders or symptoms [29]. However, *mental health* is more than just the absence of psychopathology, (e.g., the absence of depressive symptoms does not necessarily associate with better well-being) and is considered a multidimensional construct. It could be conceptualized as subjective well-being, which also includes emotional, social, and psychological dimensions [30]. *Emotional well-being* consists of positive affective (e.g., happiness) and cognitive (e.g., satisfaction with life) components [31]. *Psychological well-being* includes dimensions of psychological functioning such as autonomy, purpose in life, self-acceptance, or personal growth [32]; while *social well-being* refers to the individual's perceptions of his or her integration into society and of the coherence of the society and social events [33].

The various facets of well-being show negative associations with nonproductive thoughts [34, 35, 36], however, to date no work has been carried out to test the moderator role of gender in this relationship, in particular among adolescents. In light of the findings of a multidimensional well-being analysis across 21 European countries, we could hypothesize that gender and age are those key demographic variables which could significantly impact well-being [37] or moderate these associations [28].

Nonproductive thoughts not only affect subjective well-being but are also thought to contribute to physical health. According to the theoretical framework of Brosschot and colleagues [38] nonproductive thoughts (manifested as rumination and worry) could be also defined as perseverative cognitions which convert immediate psychological and physical concomitants of life events and daily stressors into prolonged physiological activation, which may lead to a chronic pathogenic state and ultimately to somatic disease [38, 39]. A series of studies have so far suggested significant associations between perseverative cognitions and self-reported somatic symptoms [40, 41], which were also detected among children and adolescents [42, 43].

Although there are not too many theories that directly link nonproductive thoughts to somatic symptoms, we should note that the literature of somatic complaints and medically unexplained symptoms is robust. Previous studies indicated that these symptoms in children are monosymptomatic, but they became polysymptomatic over time [44]. For instance, headache and stomach ache are common in smaller children, while fatigue or other neurological symptoms are present during later adolescence [45]. Due to multifinality, the presence of these symptoms during childhood and adolescence appears to be influenced by several environmental, social, individual, or emotional factors. Genetic and biological factors (such as pubertal status, maturity and hormonal changes), family and social stress, stress reactivity, socio-demographic background (e.g., lower socioeconomic status or SES), or personality traits also were identified as proximal or distal risk factors [46, 47, 48, 49]. Although we believe that the investigation of these factors is relevant, during this study we will focus on the topic of nonproductive thoughts.

The role of age and gender in (nonproductive thoughts related) somatic symptoms are often investigated from a clinical point of view, but we know from previous findings [40, 50, 51] that this topic is cardinal in non-clinical populations as well. In addition, while former studies generally investigated gender differences in nonproductive thoughts [25], very few works examined whether the strength of the relationship between nonproductive thoughts and somatic symptoms varied by gender or age.

In light of the above, we aimed to investigate the complex associations between nonproductive thoughts, somatic symptoms, and subjective well-being using multiple indicators multiple causes models. Given our existing knowledge of the matter, we hypothesized 1.) a significant positive association between nonproductive thoughts and somatic symptoms [43, 52] and 2.) negative association between nonproductive thoughts and subjective well-being [33]. Regarding the gender differences in the relationship between nonproductive thoughts, somatic symptoms and subjective well-being, we expected that 3.) girls would have higher levels of nonproductive thoughts [14, 28, 53] and somatic symptoms [42] than boys; and 4.) girls with higher nonproductive thoughts would show lower subjective well-being compared to boys [21]. However, due to the relative lack of empirical evidence we did not have prior expectations regarding the moderator role of age in these associations.

2. Method

2.1. Participants and procedure

Adolescents were selected to this representative cross-sectional study, aiming to examine the subjective well-being of school-aged juveniles [54, 55]. The cluster sampling involved every primary (14) and high school (7) of the largest district of the capital city (Budapest) targeting 2000 students. To obtain a representative sample half of the parallel classes were selected at random. Participants were asked to complete the questionnaires in their classroom within one teaching hour (45 min), while trained research assistants supervised the anonymous data collection. Every parent and student was informed in writing about the purpose of the study (students were asked to fill out a questionnaire, to help us understand how adolescents feel and think, what causes them joy or good mood or what kind of problems they have). The participation was voluntary and informed consent was received from parents and students as well. 141 parents and/or students refused to participate in the study, and 178 students were absent during data collection (the rate of missing

data was 20%). Data were successfully collected from 1625 students, although 53 subjects were excluded from the final analysis due to incomplete data. The final representative sample composed of 1572 students (mean age = 15.39; SD = 2.26 years), 770 boys (49%) and 802 girls (51%).

2.2. Ethics approval

The study was approved by the Institutional Review Board of ELTE Eötvös Loránd University (Hungary). All participants and their parents provided written informed consent before entering the study and the work was conducted in full compliance with the principles of the Declaration of Helsinki.

2.3. Consent for publication

Not applicable.

2.4. Measurement methods

2.4.1. Somatic Complaint List (SCL)

SCL [56] is a one-factor, 11-item scale measuring the occurrence of somatic complaints or symptoms (*dizziness, tiredness, stomach ache, feeling well, pain in arms and legs, weak in the body, feeling healthy, headache, feeling ill, shaky or shivery, and nausea*). Participants were asked to score the items on a 5-point Likert scale (*1 = almost never - 5 = quite often*), where higher scores reflected more symptoms, with the exception of two reverse scored items (i.e., *"well"; "healthy"*). Although SCL is often reported with 3-point scale, we followed the recommendation of Jellesma and colleagues (2007) [56], who changed the 3-point scale to a 5-point scale, in order to increase the weight of single symptoms. The sum of the scores was calculated and used in the analyses. In our study, SCL covered the last two weeks to decrease the time of retrospection since middle schoolers were also involved. We used the Hungarian version of the scale [57] which proved to be a reliable instrument among adolescents [43]. Similarly to previous studies [42, 43], the internal consistency was supported as Cronbach's alpha and omega total values were .81 and .84, respectively.

2.4.2. Nonproductive Thoughts Questionnaire for Children (NPTQ-C)

NPTQ-C [58] is a one-factor scale consisting of 10 items which assess perseverative trait-like thoughts (e.g., *"I am often worried"; "When I have a problem, I can't stop thinking about it"*). Participants were asked to score the items on a 3-point scale, ranging from 1 to 3 (1= *not true, 2 = sometimes true, 3 = often true*) where higher scores reflected more nonproductive thoughts (except one reversed item, i.e., *"Problems never worry me. I just solve them.*"). The sum of the scores was calculated and used in the analyses. The internal consistency of the original NPTQ-C proved to be good (Cronbach's alpha = .84). The Hungarian version of the questionnaire [54] also used the one-factor structure, and had configural, metric and scalar level gender invariance. The internal consistency of the scale was supported (Cronbach's alpha = .83, ωtotal = .85).

2.4.3. Mental Health Continuum-Short Form (MHC-SF)

MHC-SF [59] is a self-reported 14-item instrument that quantifies mental health via three dimensions: emotional (e.g., "*How often did you feel interested in life?*"), Psychological (e.g., "*How often did you feel confident to think or express your own ideas or opinions?*") and social well-being (e.g., "*How often did you feel that people are basically good?*"). Respondents were asked to indicate how often the items applied to themselves in the last month on a 6-point scale (*0= never - 5= every day)*. The sum of the total scores and the scores belonging to each subscale was calculated (ranging from 0 to 15 for emotional well-being, from 0 to 30 for psychological well-being and from 0 to 25 for social well-being) and used in the analyses where higher scores represented higher well-being. As in the original version, in both the Hungarian version [55] and the present study, Cronbach's alphas ranged from .73 to .87. in all subscales, supporting internal consistency.

2.5. Statistical analysis

The statistical analysis was performed in Mplus 8.0 statistical software [60] and SPSS version 23.0 (IBM). Results were visualized using SPSS and the internet version of ModGraph-I [61].

In order to explore the putative moderation effects of age and gender on the relationship between nonproductive thoughts, somatic symptoms and well-being, four multiple indicator multiple causes (MIMIC) models were defined. This modelling technique which is a specific form of structural equation modelling or an extension of confirmatory factor analysis with covariates, can simultaneously estimate the effect of indicators on latent variables and the direct effects of (continuous or categorical) exogenous variables on the latent variables [62].

In the first model (Model 1) we tested how age, gender and nonproductive thoughts (measured by NPTQ-C) were associated with somatic symptoms (measured by SCL). Age, gender and NPTQ-C were included as observed independent variables, while SCL was defined as latent dependent variable.

In the second model (Model 2), we measured the associations between age, gender and NPTQ-C and subjective well-being (measured by MHC-SF). Again, age, gender and NPTQ-C were included as observed variables, while MHC-SF was defined as latent (outcome) variable. In the case of MHC-SF, we used a parceling technique as we aggregated individual items into three parcels (i.e., emotional, psychological and social well-being) an used these parcels as the indicators of the dependent latent construct [63].

In the third model (Model 3) we tested the interaction effects of age, gender and NPTQ-C (gender x NPTQ-C; gender x age; age x NPTQ-C; gender x age x NPTQ-C) on somatic symptoms (SCL).

Finally, in Model 4, the interaction effect of age, gender and NPTQ-C (gender x NPTQ-C; gender x age; age x NPTQ-C; gender x age x NPTQ-C) were tested on subjective well-being (MHC-SF). Continuous variables were mean centered, gender was dummy coded before calculating the interaction terms.

Models containing SCL (Model 1 and Model 3) were estimated using the weighted least squares mean and variance (WLSMV) adjusted estimation method, while Model 2 and Model 4 were estimated by the maximum likelihood estimation with robust standard errors (MLR) method. The evaluation of model fit took into account the result of multiple fit measures. The index of Root Mean Squared Error of Approximation (RMSEA) below .05 indicates optimal fit. The values of the Comparative Fit Index (CFI) and the Tucker-Lewis Index (TLI) around .90-.95, shows acceptable model fit [64].

3. Results

3.1. Descriptive statistics

Socio-demographic variables including education (e.g., school types), living conditions (e.g., type of residence), and subjective wealth of participants can be found in Table 1.

Means, standard deviations and correlations between the variables are presented in Table 2. Girls experienced more somatic symptoms and nonproductive thoughts and lower rates of emotional and social well-being than boys. Based on the correlation matrix, there was a significant negative relationship between somatic symptoms and the well-being dimensions, and significant positive association with nonproductive thoughts. Moreover, girls and older adolescents tended to report higher rates of somatic symptoms.

Table 1. Sociodemographic data of the sample, regarding education, living conditions and subjective wealth.

Category	Sub-category	Frequency (N)	Percent (%)
Gender			
	male	770	49
	female	802	51
Grade			
primary/middle school	6th	256	16.3
	7th	192	12.2
	8th	224	14.2
high school	9th	216	13.7
	10th	241	15.3
	11th	230	14.6
	12th	170	10.8
	13th	43	2.7
Type of school			
	primary school	586	37.3
	6 classed grammar school	2	.1
	8 classed grammar school	145	9.2
	4 classed grammar school	695	44.2
	vocational school	140	8.9
	missing	4	.3
Place of living			
	capital city	1198	76.2
	town	302	19.2
	village	57	3.7
	farm	2	.1
	missing	13	.8
Type of residence			
	own detached house	846	53.8
	own apartment	557	35.4
	rental (house or apartment)	83	5.3
	other	20	1.3
	missing	66	4.2
Level of education of father			
	university or college	389	24.7
	high school	336	21.4
	vocational school	429	27.3
	primary/middle school	71	4.5
	He did not finish primary school	3	.2
	does not know	270	17.2
	missing	74	4.7
Level of education of mother			
	university or college	465	29.6
	high school	484	30.8
	vocational school	256	16.3
	primary/middle school	85	5.4
	does not know	203	12.9
	missing	79	5.0
Living status of parents			
	living together	932	59.3
	divorced	442	28.1
	separated	114	7.3
	widowed	55	3.5
	missing	29	1.8
Subjective wealth			
	excellent	174	11.1
	good	406	25.8
	average	884	56.2
	below average	78	5.0
	poor	12	.8
	missing	18	1.1

3.2. Multiple indicator multiple causes (MIMIC) models

The first MIMIC model was used to examine the direct effects of age, gender (coded as 0 = boys, 1 = girls) and nonproductive thoughts on the factor of somatic symptoms ($\chi 2$ (73) = 334.063, $p < .001$; CFI = .93; TLI = .92; RMSEA = .05). We found significant main effect of age, gender and nonproductive thoughts and the covariates explained 26% of the variance related to the somatic symptoms factor (please refer to Table 3, Panel A. for standardized regression coefficients). Based on these significant main effects, participants with higher rates of nonproductive thoughts reported an elevated level of somatic symptoms as well as girls and older participants.

In the second model, similarly to the model above, we tested the direct effects of age, gender and nonproductive thoughts on the factor of subjective well-being ($\chi 2$ (6) = 101.557, $p < .001$; CFI = .94; TLI = .87; RMSEA = .10). We confirmed the significant main effect of nonproductive thoughts and age on subjective well-being factor (see Table 3, Panel B.), and these predictors explained 23% of the variance. According to these results, older adolescents experienced lower levels of well-being than their younger peers and individuals with higher ruminative/worrying tendencies reported lower subjective well-being compared to non-ruminators.

Besides the direct effects, in the third and fourth model we also analyzed the interaction effects of age, gender and nonproductive thoughts on the somatic symptoms and subjective well-being factors, respectively. In the third model ($\chi 2$ (113) = 329.708, $p < .001$; CFI = .93; TLI = .92; RMSEA = .04) the interaction of gender x age and age x nonproductive thoughts were significant predictors of somatic symptoms (Table 4, Panel A). These results indicate that older girls tended to experience higher rates of somatic symptoms, while the level of somatic symptoms increased only slightly over time among boys. Furthermore, the strength of the association between ruminative/worrying thoughts and somatic symptoms decreased with age.

In addition, the fourth model ($\chi 2$ (14) = 99.118, $p < .001$; CFI = .94; TLI = .90; RMSEA = .06) shows that the interaction of gender x nonproductive thoughts was significant but weak predictor of subjective well-being factor (Table 4, Panel B), indicating that girls with more nonproductive thoughts experienced lower well-being compared to boys.

In order to illustrate these interaction effects, we conducted graphical moderation analyses in ModGraph_I [61]. Please, note that these figures were based on observed and not latent variables and they only serve illustration purposes. Figure 1 shows the interaction effect of gender x age on somatic symptoms, while Figure 2 demonstrates that the strength of the associations between nonproductive thoughts and somatic symptoms decreased with age (to see the role of gender in this association, please refer to Additional file 1).

Interestingly, the role of gender and age in the relation of NPTQ-C and MHC-SF showed the opposite picture. While gender x nonproductive thoughts interaction was significant (Figure 3), pointing out that girls with more nonproductive thoughts showed lower subjective well-being than boys, age only had a significant main effect, indicating that older participants had lower well-being independently of nonproductive thoughts (Additional file 1). Figure 4 shows the schematic representation of our main results.

One could be argued that the instrument we used to measure somatic symptoms contained very non-specific items (e.g., feeling ill, feeling healthy) which might be more strongly related to mental health than other specific symptoms (headache, stomach ache etc.). To eliminate this putative confounding effect, we decided to conduct a post-hoc analysis.

Table 2. Zero-order correlations, means and standard deviations of the variables, along with t-statistics and effect sizes by gender.

	Age	Gender	Somatic symptoms	Nonproductive thoughts	Emotional well-being	Psychological well-being	Social well-being	MHC-SF_total
1. Age								
2. Gender[1]	-.01							
3. Somatic Symptoms[2]	.10***	.27***						
4. Nonproductive thoughts[3]	.10**	.30***	.44***					
5. Emotional well-being[4]	-.21***	-.14***	-.38***	-.39***				
6. Psychological well-being[4]	-.11***	-.03	-.27***	-.30***	.59***			
7. Social well-being[4]	-.26***	-.06**	-.21***	-.24***	.51***	.55***		
8. MHC-SF_total	-.22***	-.08**	-.32***	-.35***	.77***	.88***	.84***	
Total sample, Mean (SD)	15.63 (2.24)		23.01 (7.02)	19.65 (4.53)	9.84 (3.31)	19.76 (6.07)	11.03 (5.57)	40.72 (12.60)
Boys, Mean (SD)	15.40 (2.21)		21.06 (6.15)	18.23 (4.29)	10.36 (3.11)	20.02 (5.98)	11.45 (5.56)	41.73 (12.25)
Girls, Mean (SD)	15.37 (2.30)		24.81 (7.35)	20.99 (4.37)	9.42 (3.40)	19.61 (6.09)	10.78 (5.61)	39.77 (12.85)
t-statistics	0.27		10.51***	12.44***	5.67***	1.30	2.25*	2.91**
Effect size (Cohen's d)	0.01		0.56	0.63	0.29	0.07	0.19	0.16

Note. Total Sample: N = 1572; Boys: N = 770 (49%); Girls: N = 802 (51%). [1] – Gender: 1 = Boys, 2 = Girls; [2] – Somatic symptoms were measured by the SCL; [3] – Nonproductive thoughts were measured by the NPTQ-C; [4] – Well-being domains were the subscales of the MHC-SF; NPTQ-C= Nonproductive Thoughts Questionnaire for Children, SCL = Somatic Complaint List; MHC-SF_total = Mental Health Continuum-Short Form total score; SD = standard deviation; *p < .05; **p < .01; ***Bonferroni corrected p < .0008.

Table 3. Standardized regression coefficients between nonproductive thoughts, somatic symptoms and subjective well-being.

Model 1 Main effects A		Model 2 Main effects B	
Gender	.15***	Gender	.01
Age	.10***	Age	-.22***
NPTQ-C	.42***	NPTQ-C	-.41***
R^2	.26	R^2	.23
Dependent variable= SCL		*Dependent variable= MHC-SF*	

Note. NPTQ-C=Nonproductive Thoughts Questionnaire for Children; SCL = Somatic Complaint List; MHC-SF = Mental Health Continuum-Short Form; *p < .05, **p < .01., ***p < .001.

Table 4. Interaction effects of age, gender and nonproductive thoughts on somatic symptoms and subjective well-being.

Model 3 Main effects and interactions A		Model 4 Main effects and interactions B	
Gender	.16***	Gender	.01
Age	-.01	Age	-.23***
NPTQ-C	.40***	NPTQ-C	-.35***
Gender x Age	.13**	Gender x Age	.02
Gender x NPTQ-C	.02	Gender x NPTQ-C	-.09*
Age x NPTQ-C	-.11**	Age x NPTQ-C	-.00
Gender x Age x NPTQ-C	.06	Gender x Age x NPTQ-C	.03
R^2	.27	R^2	.24
Dependent variable= SCL		*Dependent variable= MHC-SF*	

Note. NPTQ-C=Nonproductive Thoughts Questionnaire for Children; SCL = Somatic Complaint List; MHC-SF = Mental Health Continuum-Short Form; *p < .05, **p < .01., ***p < .001. Continuous variables were mean centered, gender was dummy coded before calculating the interaction terms.

We excluded all non-specific items of SCL, and included only those six items, which referred to specific symptoms (dizziness, stomach ache, pain in the arms and legs, headache, shaky or shivery and nauseous). The internal consistency of this modified scale was still acceptable (Cronbach α = .69). The results of the multiple linear regression analysis showed that the interaction of age and gender remained significant, showing that older girls had more somatic symptoms than boys had (standardized regression coefficient of age × gender interaction term = .102; p = .005). For more specific results and post-hoc figure, please refer to Additional file 1.

Although the focus of the present study was on the moderator analyses, we also conducted confirmatory factor analysis (CFA) to test the model fit of the single-factor measurement model of the SCL. For fit indices and factor loadings please refer to Additional file 1.

4. Discussion

The main results of the present study showed that in a non-clinical representative adolescent sample higher rates of nonproductive thoughts predicted a higher level of somatic symptoms, while nonproductive thoughts presented negative relationships with subjective well-being. Our findings also revealed that although girls were more likely to experience somatic symptoms and nonproductive thoughts than boys, the strength of the association between nonproductive thoughts and somatic symptoms was invariant across genders, and it significantly decreased with age. In addition, the interaction of gender and nonproductive thoughts was a significant predictor of subjective well-being, indicating that girls with more nonproductive thoughts experienced lower well-being than ruminator boys. The results of the present paper were in line with previous findings [56, 65], which showed that girls had a higher level of somatic symptoms and a lower level of subjective well-being than boys.

4.1. The associations of nonproductive thoughts with somatic symptoms and well-being

In our study, nonproductive thoughts were positively associated with self-reported somatic symptoms and negatively associated with subjective well-being factors. These results seem to be in line with the existing

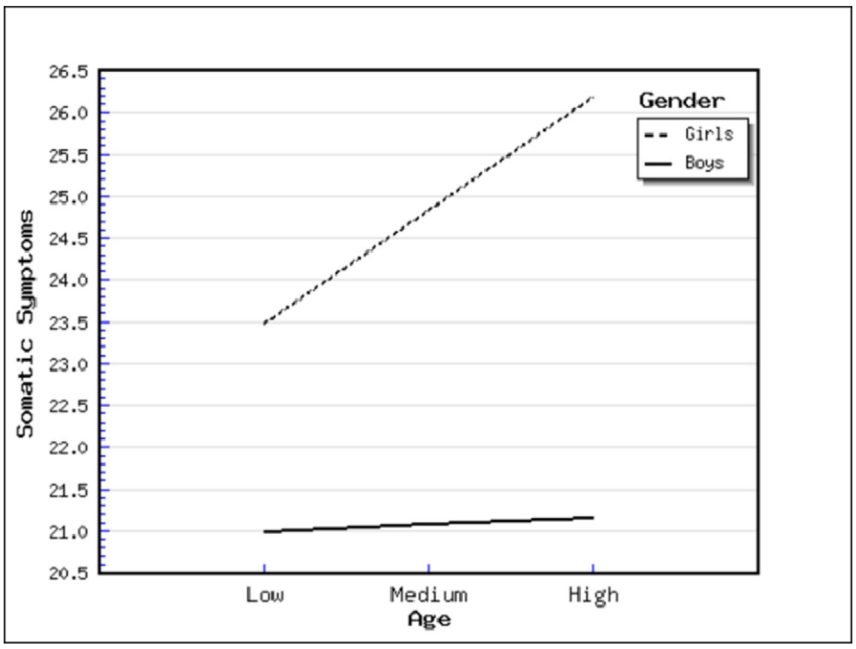

Figure 1. Interaction effect of age and gender on somatic symptoms (SCL).

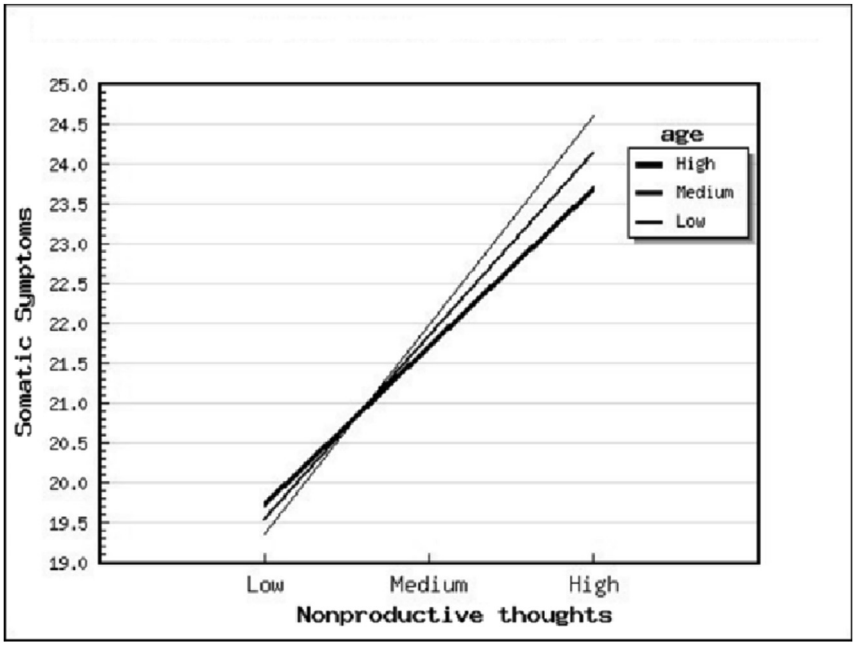

Figure 2. Moderator role of age in the relation of nonproductive thoughts (NPTQ-C) and somatic symptoms (SCL). Age categories are expressed as the mean and ±1 standard deviation.

empirical evidence, potentially supporting the perseverative cognition hypothesis [38], namely that the different forms of recurrent negative thinking (e.g., rumination and worry) tend to prolong and maintain the stress-related psychophysiological arousal and may lead to a generalized pathogenic state, which may manifest in somatic symptoms or disorders [40]. This negative relationship is well-established and supported by previous findings in adolescents and children as well [43, 66]. However, we should be cautious when we interpret our findings. We believe that due to multifinality, many other pathways or mechanism could explain our results as well. For instance, nonproductive thoughts might intensify the perception of harmless bodily sensations and magnify the influence of perceived symptoms on general health [67, 68], also, biological factors could be involved in the etiology of somatic symptoms. Pubertal status or timing could explain these somatic symptoms [47, 69], while increasing social or academic stress could also contribute to more nonproductive thoughts [70].

Although in this study we did not measure other variables such as pre-existing disease states [71], genetic and family factors [46, 49], trauma [72], pain reactivity, temperament or personality traits [48, 73] these factors were identified in the background of chronic fatigue and/or medically unexplained symptoms as well [44].

Our findings on the relationship between nonproductive thoughts and subjective well-being are also supported by other studies [34, 74]. For instance, Harrington and Loffredo (2011) found that rumination was a

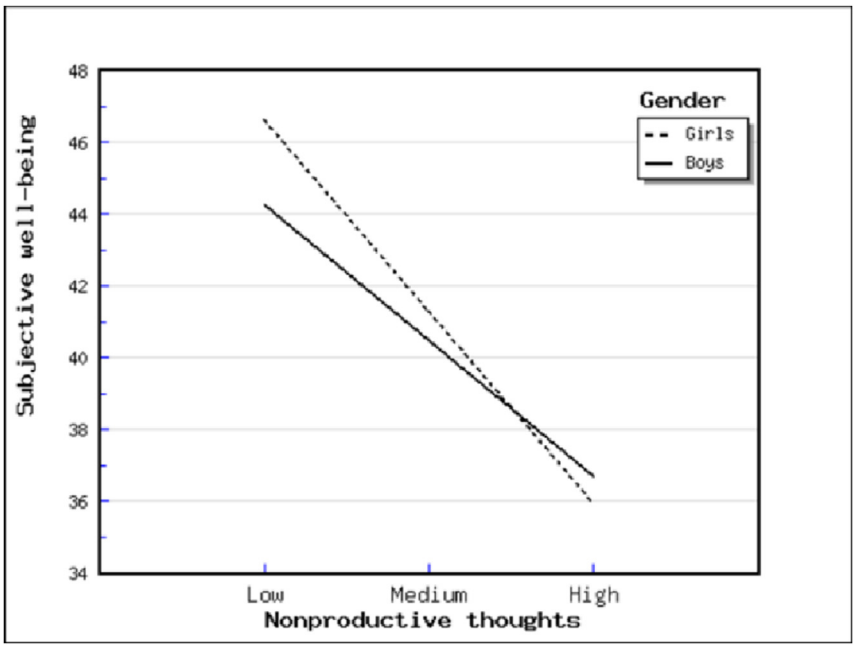

Figure 3. Relationship between nonproductive thoughts (NPTQ-C) and subjective well-being (MHC-SF) among boys and girls.

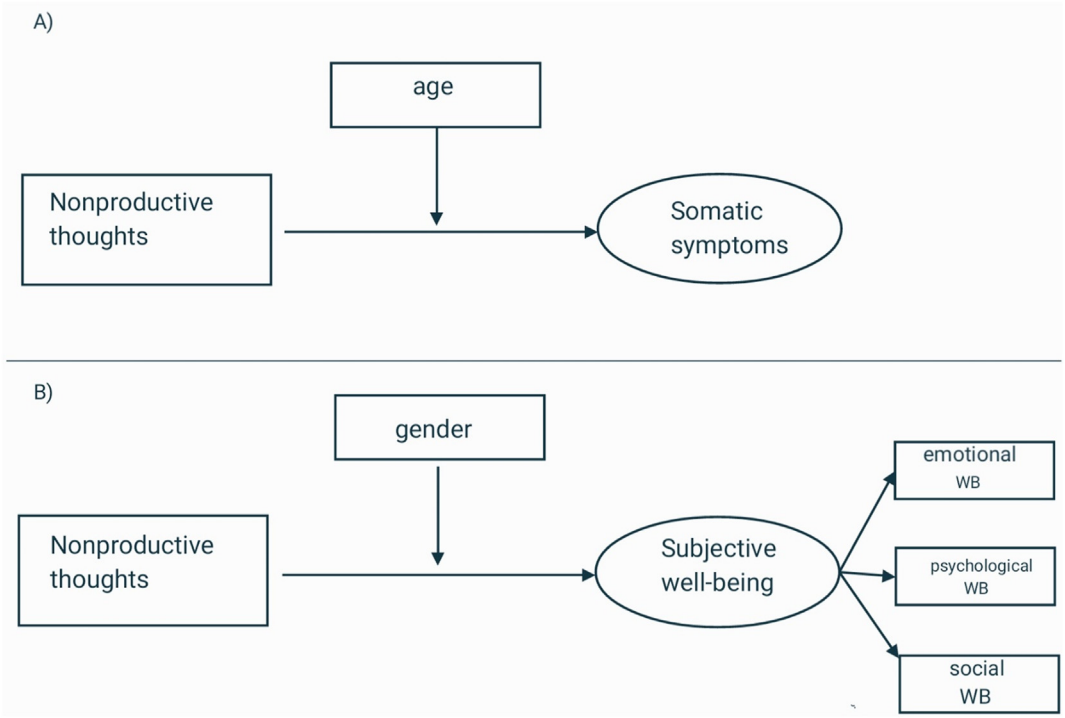

Figure 4. Schematic representation of the main results. Age as the moderator in the association of nonproductive thoughts and somatic symptoms (Panel A); the moderating effect of gender in the association between nonproductive thoughts and subjective well-being (defined by emotional, psychological and social well-being (WB) (Panel B)).

significant negative predictor for three dimensions (i.e., psychological, social and emotional) of well-being, albeit among university students [35].

4.2. How gender and age moderated the strength of these associations?

Our findings revealed that although nonproductive thoughts were strongly and equally associated with somatic symptoms among both boys and girls, the strength of this association significantly decreased with age.

Our results are somewhat consistent with but also add to previous findings [75] which indicate that there is an important shift around at age of 15 when vulnerability to rumination related somatic symptoms decreases. In addition, although the present study does not contain data on gender or age differences in relation to biological or hormonal changes, body image, pubertal status or pubertal timing, our findings may also result from these factors [47, 76].

In addition, we found that girls with more nonproductive thoughts showed lower level of subjective well-being than boys, and age only had a significant main effect, indicating that older participants had lower well-being independently of nonproductive thoughts. Due to the relative lack of studies investigating adolescents, the interpretation of our findings is limited but our results echo previous findings [77] and draw attention to the need for future research in this field.

4.3. Somatic symptoms and subjective well-being across gender and age

Beyond the effect of nonproductive thoughts, it is worth examining the role of age and gender in somatic and subjective well-being. In line with previous findings [75, 78] we found that girls had more somatic symptoms than boys. Furthermore, a significant age × gender interaction emerged indicating that the prevalence of these symptoms significantly increased with age among girls but not among boys. Our results are consistent with previous studies [79] which found different trend patterns in psychosomatic health problems across genders: among 15-16-year-old boys there were only small changes on average over time, while among girls a significant increase was detected in the level of psychosomatic problems.

However, the conclusions from a cross-cultural longitudinal study could further refine the interpretation of our results. Janssen and colleagues (2011) investigating the association between pubertal timing and somatic symptoms among American and Dutch adolescents found that most somatic symptoms decreased with age [47], while we found an opposite pattern. These differences might be attributed to the different cultural and educational context. The transition from primary/middle school to grammar school is a major social and educational change in the lives of our participants, which might be stressful and challenging. Since social stress is a known risk factor for somatic symptoms [44], this might explain our results. In addition, our study was cross-sectional, so we could not analyse the change in somatic symptoms individually, which could be (at least partly) accountable for the different results. It is worth enhancing that our results are in line with the cross-sectional findings of Romero-Acosta and colleagues (2013), who detected increasing somatic symptoms, especially until 14–15 years of age [75].

Our study also shed light on the influence of age and gender on subjective well-being. We found that boys reported a significantly higher level of subjective well-being than girls did and all aspects of well-being decreased with age regardless of gender.

As we outlined in the introduction, several studies [22, 29] found significant gender differences in internalizing psychopathologies (i.e., more females suffered from mood and anxiety disorders than males) in adolescence, but there are many contradictory results regarding well-being. One reason for these discrepancies could be different interpretations of the concept. Subjective (or psychological) well-being, as an umbrella term, is often used for the evaluation of self-esteem, optimism, happiness, life satisfaction or even body image [80] causing mixed results. For instance, studies on body image [81] or global self-esteem [82] showed clear gender disparities favoring men, but studies on life satisfaction among adults indicated no gender differences [31]. Naturally, it is important to acknowledge that the lack of significant findings does not mean that there are no real differences.

Despite the aforementioned contradictions there is empirical evidence which is line with our results [83]. Derdikman-Eiron and colleagues (2011) for example, found that adolescent boys (without symptoms of anxiety or depression) had higher subjective well-being than girls [65].

Our study also demonstrated that there is a general, gender-independent decrease in well-being with age. Although further studies are definitely needed to elucidate these associations, the intensifying school- or peer-related stressors such as academic demands [84], more failures in school [85], being bullied or not accepted by peers [86, 87] or increasing stress [88] may contribute to lower well-being levels.

4.4. Limitations

The present study has some limitations that should be noted. Our sample consisted of school-aged adolescents; therefore, the generalizability of the results to other (e.g., clinical) populations or age ranges is questionable. Although we found interesting age differences during our analyses, the cross-sectional study design does not allow for conclusions about the developmental aspects of somatic symptoms. Due to this design, we could not exclude the possibility that low well-being or somatic symptoms had an effect on nonproductive thoughts. However, a prospective study highlighted that nonproductive thoughts preceded the development of somatic symptoms in adolescence, potentially assuming a unidirectional relationship between them [87].

In addition, the cross-sectional design does not allow us to quantify social selection processes. We should note that inequalities in subjective well-being could follow a socio-economic gradient, therefore the expected poorer subjective well-being could be associated with lower SES as well [89]. Due to the cross-sectional design, we could not investigate the changes in pre-existing conditions (e.g. SES) and could not relate them to changes in well-being or somatic symptoms.

Despite that we know from the results of previous studies that there is a significant link between bullying and well-being [90] where rumination also seems to be a mediator [91], its measurement was outside of the scope of our research. We aimed to test whether regularly occurring nonproductive thoughts are indeed related to more somatic symptoms and lower subjective well-being. It is worthwhile to mention that nonproductive thoughts appear not only as a result of outstanding, negative life events (such as bullying), but also as a result of everyday annoyances, “small” negative experiences or perceived failures (e.g., not getting the best grade on a test) [67].

Furthermore, data collection procedure was representative for that district of the capital city (half of the parallel classes were selected from every school of the district), but it might not be representative for non-urban populations. Based on previous results urban-rural health differences should be taken into account when we measure subjective well-being or somatic symptoms [92]. For instance, Zijlema and colleagues (2015) found that living in an urban area was associated with lower odds for metabolic syndrome but was disadvantageous for respiratory system or mental health [93].

Another limitation of our study is that we did not measure acute or perceived stress. Based on the literature we could expect that somatic symptoms could mediate and/or moderate the association between acute stress and well-being [94]. For this reason, in future studies, it would be beneficial to investigate the interaction of perceived stress and nonproductive thoughts on well-being and somatic symptoms.

Finally, although rumination is a multidimensional construct, we did not measure its two facets: maladaptive brooding and the more adaptive reflective pondering. These components have different associations with psychopathologies (especially depressive symptoms) [95, 96], therefore their simultaneous assessment (e.g., by means of the widely-used Ruminative Response Scale) would have been beneficial. We wanted to use a questionnaire, which is short and can be easily understood by 10-year-old preadolescents, hence we chose the NPTQ-C.

5. Conclusions

The findings of the present study further enhance [43, 97] the significant interplay of nonproductive thoughts and somatic symptoms among adolescents, and highlight that, besides mental disorders [14, 29], nonproductive thoughts have a significant, negative association with subjective well-being. Moreover, our results indicate that the strength of the association between nonproductive thoughts and somatic symptoms is invariant across genders but shows age-related disparities. At the same time age does not moderate the association between nonproductive thoughts and subjective well-being, but gender has a moderating effect enhancing the vulnerability of girls with elevated level of nonproductive thoughts.

In light of the results of Bohman and colleagues (2018), who found that somatic symptoms in adolescence predicted severe adult mental illnesses regardless of comorbid depression or anxiety [98], we believe that our findings may have important implications for adolescents. The early mapping of the underlying factors behind somatic symptoms could aid the design of tailored prevention and intervention programs.

Declarations

Author contribution statement

Natália Kocsel; Zsolt Horváth: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Melinda Reinhardt: Conceived and designed the experiments; Performed the experiments; Wrote the paper.

Edina Szabó: Contributed reagents, materials, analysis tools or data; Wrote the paper.

Gyöngyi Kökönyei: Conceived and designed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.

Additional information

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