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Pain is associated with poorer grades, reduced emotional well-being, and attention problems in adolescents

ACADEMIC PERFORMANCE IN ADOLESCENTS WITH PAIN

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Abstract

Objectives The purpose of the present study was to determine whether pain is associated with specific aspects of academic performance, i.e. poorer grades, and with factors critical to an adolescent's academic performance, i.e. decreased emotional well-being and attention problems. We hypothesized that the association between pain and school grades is mediated by emotional well-being and attention problems. **Methods** In a large cross-sectional study, we collected data from 2215 pupils, aged 12-13 years old. Pain (no, occasional, and frequent), emotional well-being, and attention problems were measured with self-rating scales. Dutch, English, and math grades were taken as an index of academic performance. **Results** Frequent pain in adolescents was associated with poorer grades (Dutch p=.02 and math p=.01). Both occasional and frequent pain were associated with reduced emotional well-being (p=<.001) and reduced self-reported attention (p=<.001). However, the association between pain and lower grades disappeared when controlling for emotional well-being and attention. **Discussion** The present study shows that the association between pain and Dutch grades is mediated by reduced emotional well-being and attention problems. The association between pain and math grades is mediated by emotional problems. The results suggest that an intervention targeted at pain in adolescents could have a positive effect on emotional well-being, attention, and school performance.

Keywords

Adolescents, pain, academic performance, attention problems, emotional well-being

Introduction

In the general population, approximately 25% of all children and adolescents suffer from chronic pain [1]. Chronic pain in children and adolescents is not often caused by a serious physical disease [2, 3]. Pain-related complaints are commonly described as 'functional' or 'medically unexplained'. Nevertheless, recurrent pain negatively influences the quality of life

of these adolescents and their families [4]. Children and adolescents with chronic pain participate less in physical activities and report reduced emotional well-being in comparison with their peers.

Adolescents with recurrent pain are also frequently absent from school [5-8]. The results of a study by Konijnenberg and colleagues showed that almost half of the children with unexplained chronic pain who were clinically referred had been absent from school for at least 1 to 3 days per month [9]. Even more concerning is that 14% of the children with chronic pain reported that they had not attended school for a period of 3 months or longer. Similar results have been found in community samples [10]. The results of a study by Roth-Isigkeit and colleagues showed that almost half of the children and adolescents reporting pain in the preceding three months had missed school because of this pain [10].

Only a few studies have examined whether school absenteeism in adolescents with chronic pain results in problems in academic performance. For example, a cross-sectional study by Logan and colleagues reported that the current grades of 44.3% of adolescents with chronic pain were poorer than before the onset of chronic pain. Additionally, adolescents with chronic pain perceived pain to interfere with their school success [11]. Ho and colleagues found youngsters with chronic pain to score within the average range on both cognitive and academic performance measures (e.g., word reading, mathematical reasoning and written expression) [12]. Although the results of Logan and colleagues and Ho and colleagues might seem contradicting, this is not necessarily the case. Adolescents may experience a drop in their academic performance, while their cognitive and academic functioning remains within the average range.

It is known that subclinical depressive symptoms are common in children and adolescents with chronic pain [13-15]. Depressed adolescents often complain to be easily distracted and to have memory difficulties [16]. Therefore, some studies suggest that the

association between pain and problems in academic performance might be explained by reduced emotional well-being and/or attention problems. A cross-sectional study by Logan and colleagues [17] showed an association between emotional well-being and poorer academic performance in clinically referred adolescents (aged 12-17 years) with chronic pain. Emotional well-being seemed to have more impact on academic performance than factors such as pain intensity and pain duration. Apart from attention problems caused by co-morbid depressive symptoms, such problems may also be caused directly by chronic pain complaints [18]. The function of pain is to protect us from harm. A pain signal is commonly evaluated as threatening and therefore might override all other cognitive demands. As a consequence, adult patients with chronic pain often report attention problems [19]. To our knowledge, data on self-perceived attention problems is not yet available for children and adolescents with chronic pain.

Building on previous work, the present study focuses on the relationship between self-reported pain, emotional well-being, and attention and academic performance in a large normal population sample of Dutch adolescents in grade 7 (12-13 years old). The following hypotheses were tested: 1. Pain is associated with poorer grades, reduced emotional well-being, and more attention problems. 2. Part of the association between pain and grades is explained by reduced emotional well-being and/or attention problems. The present study is the first to examine both emotional well-being and attention problems as mediating mechanisms in the relationship between pain and school functioning. Knowledge of mediating mechanisms is of value for youth health practitioners and for school teachers, as it may be used to guide interventions.

Materials and Methods

Population

The present study is part of the large cross-sectional study that examines risk and

protective factors associated with good academic performance and school functioning in the Netherlands. Subjects were recruited between January and April 2011 and were all in their first year of secondary school (grade 7). Subjects were enrolled within ten regular secondary schools in the Netherlands; schools with varying educational levels, i.e., ranging from "pre-vocational secondary educational level" via "higher general educational level" to "pre-university secondary educational level". The schools offered both single-track classrooms and combined track classrooms. In the combined classroom type, students stream into a single-track classroom in grade 8 or 9. The schools were located in the provinces Limburg, Noord-Holland, and Gelderland. Adolescents were sent consent forms, with parents providing informed written consent and children assenting prior to participating in the research. Approximately 83% of the invited adolescents finally participated in the study. Data were collected for 2,215 pupils and 1854 mentors. In the Netherlands, a mentor is a teacher that guides a specific class and helps when the pupils experience problems at school. Adolescents were not compensated for taking part in de study.

Instruments

Demographics Demographic data included the pupil's gender, age, ethnicity (Dutch, Western minorities, and non-Western minorities), and education level (pre-vocational secondary education, higher general secondary education, a combination of higher general secondary education and pre-university education, pre-university education, and pre-university education with additional classical languages) and was measured using a survey.

Pain Pain was measured with a single question: "Did you experience any pain (e.g. headache or abdominal pain) that interfered with studying and school during the last three months?" The question was answered on a 3-point Likert scale (0 = *no*, 1 = *occasionally*, and 2 = *frequently*).

Attention The Attention subscale of the Amsterdam Executive Function Inventory (AEFI) was used to measure self-reported attention problems [20]. The Attention subscale consisted of 6 items (e.g., 'I am easily distracted'). The responses for the items were presented on a 3-point Likert scale (1 = *not true*, 2 = *partly true*, and 3 = *true*). A higher score was indicative of more attention problems (range: 6-18). The psychometric qualities of the AEFI are acceptable [20]. In the present study, the internal consistency of the Attention subscale of the AEFI was α = .72.

Emotional well-being The Emotional Well-being subscale of the Maastricht Cognition Questionnaire for Children and Adolescents (MCQCA) was used to measure self-reported emotional well-being [20]. The emotional well-being subscale originally consisted of 8 items, encompassing emotional symptoms ("I feel good and I am often happy", "I am quite often angry, sad, tense or in a bad mood", "Lately, I don't feel as good as I used to", and "When I worry, I can't stop thinking about it"), wellbeing ("I am satisfied with the things I do and the way I do these things" and "I like attending school"), and somatic complaints ("I often feel sick" and "I often suffer from headaches"). However, we removed the item about headaches. This item would conceptually overlap too much with the pain measure. The responses for the items are presented on a 3-point Likert scale (with *1* = not true, *2* = partly true, and *3* = true). A higher score was indicative of more emotional problems (range 7-21). The emotional well-being subscale has not yet been validated. In the present study, the internal consistency of the Emotional Well-being subscale of the MCQCA was acceptable (α = .72). The same Cronbach's alpha was found in a study of Bratenburg-Eddes and Jolles [21].

Academic performance The schools had monitored the mean English, Dutch, and math grades of the first trimester of the school year. Grades were used to index academic performance. The mentors of the pupils provided the data. In the Netherlands, schools grade

on a scale from 1 (very poor) to 10 (excellent), with 5.5 being the cut-off between satisfactory and unsatisfactory.

Procedure

In March or April 2011 the participating pupils filled out a digital questionnaire in a classroom. Answering the questions took approximately 40 minutes. During the administration of the questionnaire there was always a researcher present to answer pupils' questions. In the present study, we only used the items about demographics, pain, emotional well-being and attention problems. The mentor of each pupil was also present and filled out one questionnaire per pupil, that approximately took three minutes. In the present study, we only used the mean Dutch, English, and math grades of the first trimester of the year as reported by the mentor. Ethics approval for the present study was obtained from the Scientific and Ethical Committee of the Faculty of Psychology and Education of the VU University, Amsterdam.

Data analyses

For the present study 2,658 pupils were invited to participate in the study. Pupils of parents who did not return a signed consent form and pupils who did not fill out the questionnaire completely, were excluded from data analysis (n = 443, 17%). A complete mentor questionnaire was available for 84% of the remaining pupils (n = 1,854). Chi square analyses and t-tests were used to examine the relationship between population characteristics (gender, ethnicity, educational level, and age) and the three categories of pain: no, occasionally, and frequently pain. Univariate the relations between pain and grades, attention, and emotional well-being were analyzed with t-tests. Two-level regression analyses were used to test the direct relationship between pain and grades, controlling for gender, age, ethnicity, and school level, as these variables were significantly related to pain in the univariate analyses. Schools were taken as the upper level, the children as the lower level. Applying the

wording of Mathieu & Tailor [22] it is preferred to use "indirect effects" instead of "mediation" when the direct effect is not significant. Multi-level multi-mediator or indirect effect analyses were analyzed in two steps [23]. First paths α were estimated with multi-level regression analyses. Second, paths β and τ' were determined. We adjusted the Sobel-Goodman test for the indirect effect of the independent variable on the dependent variable as reported in MacKinnon & Dwyer [23], following the recommendations by Krull & MacKinnon [24] for multilevel mediation analyses. Hence the mediation test was not based on the difference between τ and τ', but on the product of α and β (Equation 1). The paths τ' can differentiate between fully and partially mediated effects [22].

$$Z_{mediation} = \frac{\alpha_{ij}\beta_j}{\sqrt{\beta_j^2 se_{\alpha_{ij}}^2 + \alpha_{ij}^2 se_{\beta_j}^2 + se_{\alpha_{ij}}^2 se_{\beta_j}^2}}$$

[Equation 1]

Where *i* is the index for the independent variables and *j* the index for the mediators. For the mediated-direct ratio we estimated the τ coefficients with multilevel regression analyses including the independent variables and covariates without the mediators. The mediated-direct ratios were calculated with equation 2.

$$Ratio_{mediated-direct} = \frac{\alpha_{ij}\beta_j}{\tau_i}$$

[Equation 2]

The English, Dutch, and math grades were root-transformed and the variables emotional well-being and attention were transformed with a Blom transformation [25] to obtain normally distributed outcomes. For all differences effect sizes are reported, with *d* = .2 indicating a weak effect, *d* = .5 indicating a medium effect and *d* = .8 indicating a strong effect [26].

Results

Participant characteristics

The participating pupils were primarily Dutch (80%) and male (53%). The mean age of the pupils was 12.6 years (*SD* = .62). The majority of the pupils were involved in a combination of higher general secondary education and pre-university education (30%).

Pain

A third of the pupils (32%) reported that they were in pain occasionally. Six percent reported that they experienced pain frequently. Girls were more likely to report pain than boys. Non-Western minority adolescents were more likely to report occasional pain and Western minorities were more likely to report frequent pain. Furthermore, pain was positively associated with age. Additionally, pain differed for education level. Adolescents at the preparatory vocational education level more frequently experienced occasional pain, whereas adolescents at the pre-university educational track level with additional classical languages experienced occasional pain less frequently. Descriptive statistics are presented in Table 1.

Academic performance

Both frequent pain and occasional pain were significantly related to poorer Dutch (respectively d = .22 and d = .11) and math grades (respectively d = .28 and d = .17). English grades were not related to pain. Observed means, standard deviations, and significance of the differences are reported in Table 2.

Additionally, both frequent pain and occasional pain were significantly related to reduced emotional well-being (respectively d = 1.88 and d = .93). Both frequent and occasional pain were significantly related to attention problems (respectively d = .81 and d = .34). Observed means, standard deviations, and significance of the differences are reported in Table 2.

The direct multilevel models of relations between pain and grades, including covariates (age, gender, education level, and ethnicity), are presented in Table 3. In these multivariate models only the relations between frequent pain and the Dutch and math grades were significant (respectively $p = 0.02$ and $p = 0.01$).

Mediation and indirect effects

The estimated relations between the independents (some pain and frequent pain) and mediators (emotional well-being and attention problems), i.e. α paths, determined with multi-level models are all significant (p-values <.001) and presented in Table 4. The estimated relations between the mediators and the dependent variables (Dutch, English, and math grades), i.e. paths β, are presented in Table 5. These relations are all significant (p-values <.01), except the relations between emotional well-being and English grades and Math and attention problems (respectively $p = 0.19$ and $p = 0.48$).As presented in Table 5 the relations between independent variables and the dependent variables, i.e. τ' paths, are not significant (p-values >.05).

The mediation and indirect effects are presented in Table 6. Full mediation by emotional and attention problems is observed in the relation between frequent pain and Dutch grades . Full mediation also occurs in the relation between frequent pain and math grades. Indirect effects of emotional and attention problems are found in the relation between occasional pain and Dutch grades. Indirect effects are also present in the relations between occasional and frequent pain and English grades. Finally, an indirect effect of emotional problems is found in the relations between occasional pain and Math grades. The proportions mediated effects, calculated with equation 2 are presented in Table 6.

Discussion and Conclusion

Our results suggest that pain in early adolescence is associated with poorer Dutch and math grades, reduced emotional well-being, and increased attention problems, although the

effect sizes we found for the relationship between pain and the different grades were quite small. Furthermore, the association between frequent pain and Dutch grades seems mediated by self-reported reduced emotional well-being and attention problems. The association between frequent pain and math grades seems mediated by emotional problems. In other words, adolescents with pain might only develop problems in academic performance when emotional problems and/or attention problems exist. Our findings link to previous studies that found pain to interfere with school success [11].It is interesting that we found that pain was more related to Dutch grades than to English grades, the latter being the foreign language in the present study. One would expect that studying a foreign language would be cognitively more complex than studying the first language. It is known that when the cognitive complexity of a task increases, attentional disruption is more likely [27]. However, Dutch pupils might experience their own language as a more complex subject than English, as the Dutch language has many exceptions. Additionally, Dutch pupils only have to master the basics of English, while the English language plays a major role in their environment, i.e. films, apps, and games.

The interpretation of indirect effects is more ambiguous. If there are significant indirect effects, but no significant direct effects (paths τ), it could be argued that there should be another unobserved effect, that counteracts the observed effects of the mediators (in this case attention and emotional problems). This suggests that the model is incomplete, and open for further research.

An important strength of this epidemiological study is its large sample size and the fact that the sample is homogeneous with respect to grade and age. This increases the reliability and generalizability of the results. Another strength is that the present study was the first to examine self-reported attention in adolescents with pain.

A limitation of the present study is that pain was measured only as a single item. In the present study we do not have any information about the duration, frequency, cause, and consequences of pain. We cannot make inferences about the severity of the pain experienced by adolescents. Additionally, since our pain question includes the phrase "interfering with learning and school" it overlaps with our dependent variables (grades and attention problems), which is a source of confounding. Finally, boys and girls scored more similar on our pain measure than we anticipated based on previous studies [28], which is even more puzzling since our pain measure did not exclude pain exclusively related to the menstrual cycle. However, no further information was available to clarify this finding.

Another limitation is that the emotional well-being scale we used has not been completely validated yet. Furthermore, the removal of the item about headaches may have negatively affected the scale's validity. However, the internal consistency of the scale (α = .72) in the present sample was satisfactory and comparable with the result of a previous study [21]. A third limitation is that grades might not be the best index for school performance. It might be that adolescents with pain do not only have poorer grades, but are also at a lower educational level than could be expected, based on their intelligence. Furthermore, grades are not particularly standardized and might differ between the different educational levels. Also, some schools, although offering the same educational levels, might be more challenging than others. To minimize the effect of these factors we included educational level as a covariate in all our analyses and used multi-level analysis with school as an upper level. However, we did not have the information to include class as an extra level. Therefore, we could not correct for the possibility that different teachers grade the same work differently.

The results of the present study stress the importance of highlighting pain in the adolescent population at an early stage. With early warning signs, problems in academic performance might be prevented in adolescents with pain. Furthermore, the results can also be

used to develop appropriate psycho-educational techniques in order to help these adolescents to cope with chronic pain and related emotional problems. Psycho-educational techniques should be aimed at improving executive functions (e.g. planning and problem solving), by including cognitive coping strategies and strategies to improve attention regulation [29]. According to a multidimensional model for stress reactions in adolescents there are three types of voluntary coping: primary control, secondary control, and disengagement [30]. Primary control is defined as attempts to alter one's emotions or the stressor itself. Secondary control coping is characterized by modifying cognitions or regulating attention. Disengagement coping is defined as removing oneself from the stressor or the emotions related to the stressor. Disengagement coping is associated with higher levels of pain and primary and secondary control are found to be associated with lower levels of pain [31, 32]. Since the development of primary and secondary control coping is largely influenced by higher order executive functions [33], psycho-educational techniques might be aimed at improving executive functions, to improve coping and attention regulation.

While the present study constitutes a first step in understanding the relationship between pain and the academic performance of adolescents with pain, future research should examine the relationship between pain and academic performance in a longitudinal design or in a controlled intervention study, which makes it possible to draw inferences about cause and effect. In a controlled intervention study it could be examined whether the reduction of subjective pain in adolescents may also lead to improved emotional well-being and improved academic performance.

In conclusion, the results of the present study suggest that pain in early adolescence is associated with poorer academic performance and that attention problems and reduced emotional well-being play a mediating or indirect role in this association. The observed

findings herewith suggest that the risk of pain negatively impacting academic performance may be reduced by improving attention and emotional well-being.

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Table 1. Descriptive statistics for no pain, occasional pain, and frequent pain

	Total	No pain	Occasional pain	Frequent pain	
	n (%)	n (%)	n (%)	n (%)	$\chi^2(df)$ *p*
Total	2115 (100%)	1371 (62%)	713 (32%)	131 (6%)	
Gender					
Boys	1170 (53%)	779 (67%)	331 (28%)	60 (5%)	$23.10_{(2)} < 0.001$
Girls	1045 (47%)	592 (57%)	382 (37%)	71 (7%)	
Ethnicity					
Dutch	1753 (79%)	1117 (64%)	542 (31%)	94 (5%)	$25.4_{(4)} < 0.001$
Western-minorities	207 (9%)	125 (60%)	59 (29%)	23 (11%)	
Non-Western minorities	236 (11%)	122 (52%)	101 (43%)	13 (5%)	

Education level					
Pre-vocational secondary education	447 (20%)	246 (55%)	174 (39%)	27 (6%)	
Higher general secondary education	177 (9%)	101 (57%)	192 (32%)	37 (6%)	
Higher general secondary education + pre-university education	602 (30%)	373 (62%)	40 (24%)	6 (4%)	
Pre-university education	165 (8%)	119 (72%)	159 (26%)	33 (5%)	$32.08_{(10)}$ < 0.001
Pre-university education with additional classical languages	620 (31%)	428 (69%)			
	mean (sd)	mean (sd)	mean (sd)	mean (sd)	$t_{(df)}$ *p*
Age	12.56 (0.62)	12.53 (0.62)	12.59 (0.60)	12.66 (0.69)	$-1.95_{(2082)}$ 0.051 $-2.14_{(1500)}$ 0.032

Table 2. Estimated means and standard deviations of grades, attention and emotional problems

	No pain	Occasional pain[a]		Frequent pain[a]	
	mean (sd)	mean (sd)	$t_{(df)}$ *p*	mean (sd)	$t_{(df)}$ *p*
Dutch	6.79 (1.06)	6.68 (1.00)	$2.09_{(1556)}$ 0.04	6.55 (1.11)	$2.17_{(1141)}$ 0.03
English	7.08 (1.31)	6.98 (1.36)	$1.21_{(1555)}$ 0.23	6.87 (1.37)	$1.58_{(1140)}$ 0.11
Math	7.01 (1.19)	6.81 (1.11)	$3.42_{(1555)}$ 0.001	6.67 (1.24)	$2.68_{(1141)}$ 0.01
Attention problems	10.66 (2.83)	11.62 (2.76)	$-16.49_{(2082)}$ < 0.001	12.95 (2.82)	$-14.1_{(1500)}$ < 0.001
Emotional problems	11.93 (2.52)	14.52 (3.01)	$-7.69_{(2082)}$ < 0.001	17.46 (3.31)	$-8.75_{(1500)}$ < 0.001

[a] Reference category: No pain

Table 3. Multilevel models for direct effects (paths τ)

	Dutch (DV_1)		English (DV_2)		Math (DV_3)	
	Estimate	*p*-value	Estimate	*p*-value	Estimate	*p*-value
Intercept	-0.232	0.63	-0.122	0.80	1.039	0.03
Occasional pain (τ_1)	-0.079	0.11	-0.033	0.53	-0.094	0.06
Frequent pain (τ_2)	-0.221	0.02	-0.134	0.18	-0.242	0.01
Age	-0.014	0.69	-0.029	0.44	-0.107	0.003
Girls	0.442	<0.001	0.186	<0.001	0.017	0.71
Education level	0.069	<0.001	0.105	<0.001	0.097	< 0.001
Western-minorities[a]	-0.086	0.25	0.060	0.45	0.020	0.79
Non-Western minorities[a]	-0.055	0.54	0.123	0.20	-0.080	0.39

[a] Reference category Dutch

Table 4. Multilevel models for paths α

		Estimate	*p*-value
Attention problems	(M_1)		
Intercept		-0.160	< 0.001
Occasional pain	(α_{11})	0.348	< 0.001
Frequent pain	(α_{21})	0.800	< 0.001
Emotional problems	(M_2)		
Intercept		-0.300	< 0.001
Occasional pain	(α_{12})	0.687	< 0.001
Frequent pain	(α_{22})	1.417	< 0.001

Table 5. Multilevel models for paths β

		Dutch (DV_1)		English (DV_2)		Math (DV_3)	
		Estimate	*p*-value	Estimate	*p*-value	Estimate	*p*-value
Intercept		-0.164	0.73	-0.075	0.88	1.066	0.03
Occasional pain	(τ'	0.018	0.72	0.019	0.73	0.006	0.91
Frequent pain	(τ'	-0.004	0.97	-0.015	0.89	-0.031	0.76
Attention problems	(β	-0.116	< 0.001	-0.081	0.002	-0.017	0.48
Emotional problems	(β	-0.085	0.001	-0.037	0.19	-0.136	< 0.001
Age		-0.019	0.59	-0.032	0.40	-0.111	0.002
Girls		0.421	< 0.001	0.174	< 0.001	0.005	0.91
Education level		0.058	< 0.001	0.098	< 0.001	0.094	< 0.001
Western-minorities[a]		-0.103	0.16	0.048	0.54	0.017	0.83
Non-Western minorities[a]		-0.059	0.51	0.117	0.22	-0.060	0.52

[a] Reference category Dutch

Table 6. Mediation effects of emotional and attention problems on the relation between pain and school grades

		Dutch (DV_1)			English (DV_2)			Math (DV_3)		
		Estimate	*p*-value	Mediator or indirect effect / direct ratio	Estimate	*p*-value	Mediator or indirect effect / direct ratio	Estimate	*p*-value	Mediator or indirect effect / direct ratio
Attention problems	(M_1)									
Occasional pain	(IV_1)	4.085	< 0.001	0.508 [1)]	2.916	0.004	0.867 [1)]	0.696	0.487	0.064
Frequent pain	(IV_2)	4.249	< 0.001	0.418 [2)]	2.978	0.003	0.486 [1)]	0.698	0.485	0.057
Emotional problems	(M_2)									
Occasional pain	(IV_1)	3.220	0.001	0.740 [1)]	1.306	0.192	0.770	4.854	< 0.001	1.000 [1)]
Frequent pain	(IV_2)	3.236	0.001	0.545 [2)]	1.307	0.191	0.386	4.872	< 0.001	0.797 [2)]

[1)] Indirect effect; [2)] Fully mediated

Figure 1. paths for multi-level regression analyses