Another way of thinking about ADHD: the predictive role of early attachment deprivation in adolescents' level of symptoms

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Abstract

Purpose Attention deficit and hyperactivity disorder (ADHD) is one of the most frequent disorders in childhood and adolescence. Both neurocognitive and environmental factors have been related to ADHD. The current study contributes to the documentation of the predictive relation between early attachment deprivation and ADHD.

Method Data were collected from 641 adopted adolescents (53.2 % girls) aged 11–16 years in five countries, using the DSM oriented scale for ADHD of the Child Behavior Checklist (CBCL) (Achenbach and Rescorla, Manual for the ASEBA school-age forms and profiles. University of Vermont, Research Center for Children, Youth and Families, Burlington, 2001). The influence of attachment deprivation on ADHD symptoms was initially tested taking into consideration several key variables that have been reported as influencing ADHD at the adoptee level (age, gender, length of time in the adoptive family, parents' educational level and marital status), and at the level of the country of origin and country of adoption (poverty, quality of health services and values). The analyses were computed using the multilevel modeling technique.

Results The results showed that an increase in the level of ADHD symptoms was predicted by the duration of exposure to early attachment deprivation, estimated from the age of adoption, after controlling for the influence of adoptee and country variables. The effect of the age of adoption was also demonstrated to be specific to the level of ADHD symptoms in comparison to both the externalizing and internalizing behavior scales of the CBCL.

Conclusion Deprivation of stable and sensitive care in infancy may have long-lasting consequences for children's development.

Keywords ADHD · Regulation · CBCL · Deprivation · Adoption · Adolescence · Culture

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Introduction

Attention deficit and hyperactivity disorder (ADHD) is characterized by inattention, hyperactivity and impulsivity. It is one of the most frequent disorders in childhood and adolescence. The worldwide pooled prevalence of ADHD is 5.29 %, with gender-related differences, i.e. a higher prevalence in boys than in girls [46, 66]. Age-related differences have also been reported in developmental studies that have found a change in trajectories, with for example a clear reduction in ADHD symptomatology for inattention, hyperactivity and impulsivity at the moment of the

transition to middle school for young adolescents [33]. In several studies, ADHD has been found to interfere with adolescents' personal, social and academic development [19, 38].

The aim of the current research is to examine the predictive role of early experience of attachment deprivation for ADHD symptoms in adolescence. Two bodies of research have been dedicated to this topic. First, there have been studies in which participants' attachment and ADHD have been assessed and related to each other. Second, there have been studies of subjects, who have reported deprivation in attachment, in particular adoptees. In this second set of studies, no assessment of the children's attachment pattern has been completed prior to their adoption for practical reasons. It is assumed that adoptees are at risk of insecure attachment relationships because of their background of institutional, unresponsive caregiving and neglect [49, 65, 67].

The etiology of ADHD

Both neurocognitive and environmental factors have been related to ADHD.

According to the cognitive theories, ADHD could be explained by a low level of executive functioning characteristics, such as inhibiting prepotent responses, interference control and cognitive flexibility [4]. It could also be due to a motivation deficit [58, 59] or to a deficit in temporal processing [61]. Neurobiological explanations, such as the crucial role of the dopamine transporter gene have also been proposed [8]. It has nevertheless been recognized that neurocognitive factors cannot explain the whole variance in ADHD symptoms [45].

Environmental factors have been reported as implicated in the etiology of ADHD [23]. Researchers have examined whether and to what extent ADHD symptoms are related to the characteristics of the cultural and the family environments. With regard to the characteristics of the cultural environment, ADHD has been considered as a relevant construct across cultures [6, 9]. However, cross-cultural variations have been found in the assessment of ADHD symptoms in children and adolescents as well as in parental explanatory models of ADHD [10, 34, 48]. In addition, findings among adoptees have recently been published showing the importance of the country of origin, in particular in Eastern Europe, for attention problems later on [3].

With regard to the characteristics of the family environment, ADHD has been found to be more common among children reared in families experiencing adversity such as marital discord, low socio-economic status, large family size, paternal criminality, and maternal mental disorder [44, 51, 52, 70]. ADHD has also been found to be related to negative parent–child relationships. Numerous studies have

reported that coercive parenting styles are predictive of ADHD symptoms [18, 29]. However, much less attention has been paid to the attachment framework in order to document the importance of the quality of parent–child relationship in ADHD. The attachment framework provides an interesting new way of thinking about ADHD. In particular, the recent developments in attachment theory have shown the role played by attachment security in the child's emotional and behavioral self-regulation [69, 72], and this important role has also been stressed in connection with ADHD [5, 11, [71]. The attachment framework is actually a theory about how a child learns to regulate his/her own affect as a result of how sensitively caregivers respond to the child's needs and help him/her to learn to self-regulate [39]. Attachment theory is a model of the development of self-regulation, and where self-regulation is disturbed, as is the case in ADHD, this suggests that attachment theory will be relevant to consideration of the etiology of the syndrome.

Attachment and ADHD

Attachment theory assumes that the early caregiver-child relation is crucial for the emergence of the self-regulatory skills [39] the lack of which is implicated in ADHD symptoms [5, 71]. The predictive link between attachment and ADHD has been empirically observed. It has been illustrated in several clinical reports and case studies reporting insecure attachment among ADHD children and adolescents [14, 15, 42, 62]. The link between attachment and ADHD has also been cross-sectionally examined. These studies documented the co-occurrence of ADHD symptoms and insecure attachment. For example, insecure attachment score has been related to hyperactivity and inattention symptoms among 384 11–16 year-old adolescents [30]. Control–case studies have also provided support for the relation between attachment insecurity and ADHD. For example, 19 boys aged 5–10 years with a diagnosis of ADHD were compared with 19 control children with respect to attachment. Consistent support was found for the association between attachment insecurity and ADHD [13]. Finally, the predictive relation between attachment and ADHD has been supported by only a few longitudinal studies. For example, ADHD has been assessed among 53 6–8 year-old children identified as having significant levels of disorganized attachment at 1 year of age. The results showed that attachment disorganization was correlated to ADHD scores for both inattention and hyperactivity symptoms 6 years later [45].

ADHD in adoptees

Adoptees have experienced parental separation and early attachment deprivation, i.e. lack of assistance with affect regulation in early childhood, lack of reciprocity, or lack of

empathetic emotional mirroring by the caregiver and associated emotional containment, which potentially harm infant functioning and later development. Neglect in 1 months of life, i.e. the lack of caregiver's care and nurturance, has been found to have deleterious effects on children's cognitive, socio-emotional, and behavioral development [24, 40, 55, 68]. A meta-analysis of 98 adoptee-control studies concluded that despite low to moderate effect sizes, adoptees displayed on average higher levels of both externalizing and internalizing problems than controls [28]. In addition, when compared with their non-adopted siblings, adoptees' adjustment was worse in late adolescence [73].

More specifically, ADHD has been considered as a characteristic outcome of early deprivation. Indeed, inattention and overactivity symptoms have even been thought to form an institutional deprivation syndrome [31, 50, 60]. Both control–case and follow-up studies from the adoption literature provide interesting information about the influence of early attachment deprivation on ADHD.

Recent case–control studies have consistently reported group differences, with more pronounced ADHD symptoms in adoptees than in controls. These group differences were seen to be moderated by the age of adoption, which can be regarded as an indicator of the duration of exposure to early attachment deprivation [31, 37]. For example, group differences have been found between adopted children aged 8–11 years and controls with respect to ADHD symptoms [74]. A nuanced picture emerged from this study, which compared children with pronounced early deprivation and neglect, i.e. those adopted after 12 months of age and having previously been mostly in institutional care, with children with moderate early deprivation, i.e. those adopted before 8 months of age and having previously been mostly in foster care. These results suggest that the duration of exposure to early deprivation moderated the differences between the groups. Group differences were also reported in another recent study, in which the rates of ADHD medication were found to be higher among 10–15 year-old adoptees than among controls. It was also reported that the rate of such medication was likely to increase with higher age at adoption [35].

Follow-up studies have delivered results consistent with those of control-case studies. They also help document the role of individual, family and cultural risk factors in adoptees' behavioral adaptation. Lower levels of behavioral adjustment have been found to be predicted by age of adoption [53] and other risk factors, such as current age, single parenthood and culture of origin [1, 17, 75]. More specifically, ADHD seems to increase with the age of adoption, suggesting that exposure to early attachment deprivation provokes self-regulatory deficits, thus increasing children's vulnerability to ADHD symptoms [20, 37, 54].

The current study

The current study contributes to the documentation of the predictive relation between early attachment deprivation and ADHD. Data have been collected in five countries among 641 adolescents aged 11–16 who were adopted before the age of 7 years. The influence of attachment deprivation on ADHD symptoms was initially tested by taking into consideration several key variables at the adoptee and country levels that have been reported as influencing behavioral issues, in particular ADHD. It will be recalled that age- and gender-related differences in ADHD have been found [33, 46] and the risk for ADHD has turned out to be higher in families experiencing adversity such as low socio-economical status or marital discord [44, 52, 70]. Cross-cultural variations in the assessment of ADHD symptoms as well as in the explanatory models of the syndrome have been reported [10, 34, 48], and variations in the level of attention problems have been displayed among adoptees according to their country of origin [3]. It was hypothesized that an increased level of ADHD symptoms was predicted by the duration of exposure to early attachment deprivation, estimated from the age of adoption, over and above the influence of adoptee variables, i.e. age, gender, length of time in adopting family, parents' educational level as a proxy of SES and marital status, and country variables, i.e. social and economic development, quality of health services and values. It was also hypothesized that ADHD symptoms are a characteristic outcome of early deprivation [31, 60]. A nonsignificant main relation was therefore expected between the duration of exposure to early deprivation, estimated from the age of adoption, and other outcomes, in particular externalizing and internalizing behavior.

Method

Sample

This study is part of the Attachment in Adopted Adolescents Research Network (AAARN). For the current research, the inclusion criteria were that the child had been adopted before the age of 7 years, i.e. a maximum of 84 months of early attachment deprivation, that they were aged 11–16 years, and that they knew they had been adopted.

Adoptee variables

Data were collected from 641, 11–16 year-old ($M = 13.45$, SD $= 1.64$) adolescents (53.2 % girls). The majority had been adopted from another country (93 %). Prior to their

adoption, most children had lived in institutions that provided them with adequate physical resources but not consistent, responsive caregiving. Therefore, the age of adoption, i.e. the number of months spent in the country of origin, ranging from 0 to 82 months ($M = 16.50$, $SD = 20.08$), was considered as a measure of the duration of exposure to early attachment deprivation. On the other hand, the length of time in the adoptive family was also considered to avoid confusing causal effects, as the symptoms may have been aggravated by the behavior of the adoptive parents. The length of time in the adoptive family ranged from 4 to 17 years ($M = 11.89$, $SD = 2.27$).

The educational level of the adoptive parents was taken as a proxy for socio-economic status (SES). Educational level is highly correlated to SES in most developed countries [43]. Moreover, owing to the current worldwide economic context, educational level is preferred as a stable indicator, rather than for example, family income, which may fluctuate. The adoptive parents' educational level was classified into five groups: elementary school ($N = 46$ (7.2 %) mothers and $N = 48$ (7.5 %) fathers), secondary school ($N = 159$ (24 %) mothers and $N = 130$ (20.3 %) fathers), undergraduate studies ($N = 199$ (31 %) mothers and $N = 163$ (25.4 %) fathers), graduate studies ($N = 173$ (27 %) mothers and $N = 181$ (28.2 %) fathers) and postgraduate studies ($N = 62$ (9.7 %) mothers and $N = 93$ (14.5 %) fathers). Note that this information was missing for 2 mothers and 26 fathers, mostly in the case of single-parent families. The data for the single mother or single father were considered for these families. To reduce the number of constructs in the analyses, the parents' educational level was averaged from the mother's and the father's levels ($r = 0.56$, $p < 0.001$).

Marital status was considered in a dichotomous manner to contrast two-parent families with adoptive parents living together ($N = 533$, 83.1 %) and alternative situations of single parenthood with the parent living alone (single parent, divorced or widowed) or living with a partner other than the other adoptive parent ($N = 96$, 15 %). Note that this information was missing for 12 (1.9 %) families.

Country variables

The adolescents had been adopted in Canada ($N = 367$, 57.3 %), The Netherlands ($N = 174$, 27.1 %), Romania ($N = 43$, 6.7 %), Belgium ($N = 33$, 5.1 %) and Chile ($N = 24$, 3.7 %). Several characteristics of both the adoptive country and the country of origin were considered in the current study.

The adopted adolescents came from 30 different countries: 108 from Sri Lanka (16.8 %), 83 from Romania (12.9 %), 70 from China (10.9 %), 59 from South Korea (9.2 %), 58 from Colombia (9 %), 48 from Mexico (7.5 %), 47 from Haiti (7.3 %), 37 from Russia (5.8 %), 25 from Taiwan (3.9 %), 25 from Chile (3.9 %), 12 from Guatemala (1.9 %), 11 from Bolivia (1.7 %), 11 from Vietnam (1.7 %), 9 from Brazil (1.4 %), 6 from El Salvador (0.9 %), 5 from Peru (0.8 %), 4 from Ethiopia (0.6 %), 3 from Costa Rica (0.5 %), 3 from the Philippines (0.5 %), 3 from Poland (0.5 %), 3 from Honduras (0.5 %), 2 from Thailand (0.3 %), 2 from Belgium (0.3 %), 1 from Ukraine (0.2 %), 1 from Cape Verde (0.2 %), 1 from Bulgaria (0.2 %), 1 from Cambodia (0.2 %), 1 from India (0.2 %), 1 from Lithuania (0.2 %), and 1 from Venezuela (0.2 %).

Because it was not possible to record data at an individual level concerning the characteristics of children's caregiving settings in their country of origin, we chose to extrapolate from the global characteristics of childcare and health conditions in the countries of origin. It was considered that the level of social and economic development as well as the quality of the health system in the country of origin may have influenced the quality of the caregiving environment in an institution prior to adoption. These cultural characteristics could therefore impact the adolescents' level of ADHD symptoms. They are shared by all participants coming from the same cultural background. In taking them into consideration in the current study, we sought to disentangle the effect of duration of exposure to early attachment deprivation at the individual level from the effect of shared cultural experience of health system and care services. First, the social and economic development in the country of origin was assessed using the Human Development Index (HuDI), which was developed by the United Nations Development Programme and published in 2008. It is provided by the CIA World Factbook [12] with the collaboration of the Organisation for Economic Co-operation and Development (OECD) and the World Health Organization (WHO). In the HuDI, the higher the score, the higher the social and economic development in the country. Indicators are used to measure the critical indicators of life expectancy, educational attainment and income. In our sample, the HuDI scores in the countries of origin ranged from 0.35 (the lowest score, for Ethiopia) to 0.90 (the highest score, for Belgium) ($M = 0.75$, $SD = 0.08$). Second, the quality of the health system was assessed by means of the ranking given by the World Health Organization. Five performance indicators were used to measure health systems in 191 WHO member states: overall level of population health; health inequalities (or disparities) within the population; overall level of health system responsiveness (a combination of patient satisfaction and how well the system acts); distribution of responsiveness within the population (how well people of varying economic status find that they are served by the health system); and the distribution of the health system's

financial burden within the population (who pays the costs). The WHO ranking provides relative scores, i.e. societies are compared with other societies. The higher the rank, the better the health system in the country. In our sample, the WHO ranking in the countries of origin ranged from 21 (the highest rank, for Belgium) to 180 (the lowest rank, for Ethiopia) ($M = 92.38$, SD $= 46.18$). The correlation between the HuDI score and the WHO ranking was -0.61, $p < 0.001$.

With regard to the countries of adoption, it was considered that both cultural values and the quality of the health system could influence the adolescents' level of ADHD symptoms. These cultural characteristics could hence impact expectations about the behavioral adjustment of adolescents according to cultural standards of normality [16, 63], as well as the quality of care and mental health services in the country of adoption, and the support and help given to the adoptive family where necessary. First, the quality of health system in the country of adoption was assessed using the WHO ranking as described above. In our sample, the WHO ranking in the countries of adoption ranged from 17 (the highest rank, for the Netherlands) to 99 (the lowest rank, for Romania) ($M = 28.21$, SD $= 12.21$). Second, the cultural values in the countries of adoption were considered on the basis of the work of Hofstede [26], in particular the individualism–collectivism dimension for each of the five countries under consideration. The high end of the collectivism–individualism dimension can be defined as "a preference for a loosely knit social framework in which individuals are expected to take care of themselves and their immediate families only". Its opposite, collectivism, represents "a preference for a tightly knit framework in society in which individuals can expect their relatives or members of a particular in-group to look after them in exchange for unquestioning loyalty. A society's position on this dimension is reflected in whether people's self-image is defined in terms of 'I' or 'we' [25]. The collectivism–individualism dimension provides relative scores, i.e. countries are compared with other countries. The higher the score, the higher the level of individualism in the country. In our sample, the individualism scores in the countries of adoption ranged from 23 (the lowest score, for Chile) to 80 (the highest score, for both Canada and the Netherlands) ($M = 76.02$, SD $= 11.46$). The correlation between the WHO ranking and the individualistic score was -0.59, $p < 0.001$.

Data collection procedure

All of the adolescents came from a community sample. Canadian data were extracted from a large dataset from the Quebec study on international adoption [21, 64]. The Canadian original dataset was obtained following authorization from the *Cour de la Jeunesse* of Quebec giving the authors access to the adoption files. For the current study, a selection of subjects corresponding to the three criteria of inclusion (see above) was made. The selected families received questionnaires by mail. A letter signed by the Secretary for the International Adoption was enclosed with the questionnaire, inviting the parents to participate. A letter of consent was also included, with a brief description of the study. The response rate was 36.8 %. In The Netherlands, the questionnaires on behavior problems were completed within a longitudinal adoption study in which internationally adopted children were followed from infancy to adolescence [7, 27]. At the start of the study, adoptive families were randomly recruited through Dutch adoption organizations. In adolescence, the adoptive families were visited at home to conduct assessments and interviews, and to administer questionnaires. Ethical guidelines were followed throughout the study and all participants gave informed consent before their inclusion in the study. At the time of the current study, adolescents from 190 families corresponded to the three criteria of inclusion. Only 15 of them (7.9 %) were not willing to participate. The Romanian data were collected with the collaboration of the governmental adoption service. Cooperation agreements were established with 9 of the 47 Romanian counties. In each of the nine counties, the child protection system established prior contact with the families that had been selected on the basis of the three selection criteria as described above. All of the families contacted within the 2-years period set for the current research project agreed and were then contacted by the research team for a meeting that took place at home or at the child protection service. Belgian questionnaires were completed by adoptive families from the French-speaking part of the country, who were willing to participate. These families were informed about the research project by social networks or by word of mouth. All the families that voluntarily contacted the research team with a view to participating within the 6 months period set for this project and that satisfied the inclusion criteria were included. Eight trained master's students visited the parents and adolescents at home in order to describe the study and give instructions on completing the questionnaires. Chilean families that met the three criteria for inclusion were recruited from the registry of adoptions at the three state agencies authorized to conduct adoptions in Chile: "SENAME" (National Youth Service), "Fundación Chilena para la Adopción" and "Fundación San José para la Adopción". Adoption agencies initially contacted 71 families to invite them to participate in the study. Thirty-seven families (52.1 %) agreed to being contacted by the research team. Of these, seven families finally decided to withdraw: three families did not want to stir up past issues, three adolescents refused to participate and one adolescent did not yet know he had been adopted. Six additional cases were

excluded because they did not meet the inclusion criteria: one adolescent had incurred a developmental disorder, in four cases, the adoption was late (after 84 months of age), and one adolescent was more than 16 years old. Finally, the Chilean sample consisted of 24 adoptive families (33.8 %). The completion of the questionnaires was organized at home. The Ethics Committee of the School of Psychology of the Pontifica Universidad Católica de Chile approved the study. All participants gave signed informed consent.

Outcome measure

The outcome variable was the current level of ADHD symptoms in adoptees assessed with the DSM-oriented scale for attention deficit/hyperactivity problems of the Child Behavior Checklist (CBCL) covering ages 6–18 years [2]. The DSM-oriented scale for attention deficit/hyperactivity problems is composed of seven items focusing on inattention, e.g. cannot concentrate, hyperactivity, e.g. cannot sit still, and impulsivity, e.g. impulsive. Strong evidence for the reliability and convergent and discriminative validity of the scale has been provided [32, 41]. The DSM-oriented scale for ADHD was completed by the adoptive mothers. The internal consistency was good, with $\alpha = 0.82$ in the whole sample and α ranging from 0.72 to 0.88 according to the five subsamples (Canada,The Netherlands, Romania, Belgium, Chile). Data were checked for normality. The test for normality was significant (Kolmogorov–Smirnov(KS) (641) = 0.17, $p < 0.001$).

Two other subscales of the CBCL, i.e. the externalizing and internalizing behavior scales, were used to test the specificity of the relation between the age of adoption and the level of ADHD symptoms. The externalizing behavior scale encompasses the rule-breaking and aggressive behavior syndrome scales. The internalizing behavior scale encompasses the anxious/depressed, somatic complaints and withdrawn syndrome scales. Since the externalizing and internalizing behavior scales were closely correlated to the DSM-oriented scale for ADHD with $r = 0.75$, $p < 0.001$ and $r = 0.55$, $p < 0.001$, respectively, the residuals of externalizing and internalizing scores have been considered as outcomes in the analyses. Data were checked for normality. The test for normality was significant both for the externalizing behavior subscale (KS (641) = 0.13, $p < 0.001$) and the internalizing behavior subscale (KS (641) = 0.13, $p < 0.001$).

Statistical analysis

A preliminary set of analyses was computed to test the main relation between the age of adoption and the level of ADHD symptoms irrespective of the adolescents' country of origin and adopting country, in a classical hierarchical regression analysis taking account of the adoptee control variables (age, gender, length of time in the adoptive family, parents' educational level and marital status). Moreover, the specificity of this relation was tested by considering the externalizing and internalizing behavior scales of the CBCL in two similar hierarchical regression analyses. Note that because of close correlations between the length of time in the adoptive family and both age and age of adoption, with $r = 0.68$, $p < 0.001$ and $r = -0.71$, $p < 0.001$, respectively, the residuals of the length of time in the adoptive family were entered as a predictor.

Second, the data were considered using the multilevel modeling technique [47]. The Hierarchical Linear Model (HLM) is a statistical (maximum likelihood) procedure designed to address the unit of analysis problem in multi-level analyses. HLM accounts for the interdependence of adolescents from the same country of origin and adopted in the same country. A two-level HLM was computed in the current study [36, 56]. It models both country-level and adoptee-level variance on the outcome, i.e. the level of ADHD symptoms. Each adoptee was therefore nested in a level 2 group according to both country of origin and country of adoption. Adoptee variables, i.e. those having a different value for each adolescent, were considered as predictors at level 1, while country variables, i.e. those having a common value for all the adolescents sharing the same country of origin and country of adoption, were entered as predictors at level 2. All available groups were considered at level 2 since "In most research, the group sizes n_j are variable between groups. […] This does not constitute a problem for the application of the hierarchical linear model in any way. The hierarchical linear model can even be applied if some groups have size $n_j = 1$, as long as some other groups have greater sizes" [57]. The total number of groups was 42 with their size varying from 1 to 108. The conditions were met for computing an HLM equation [36, 56, 57].

Results

Preliminary analyses

The results of the classical hierarchical regression analysis are displayed in Table 1.

The results show that considering age, gender, length of time in adoptive family, parents' educational level and marital status in a first step, the level of ADHD symptoms was predicted by age, gender and length of time in adoptive family. As expected, the level of ADHD symptoms was seen to decrease with age. In addition, boys displayed a higher level of symptoms than girls. Finally, the longer the

Table 1 Regression analysis predicting the level of ADHD symptoms, externalizing and internalizing behavior

	Level of ADHD symptoms	Externalizing behavior	Internalizing behavior
Step 1			
Age	−0.105**	0.120**	0.053
Gender	0.217***	−0.013	−0.168***
Length of time in adoptive family	−0.164***	−0.038	−0.097*
Educational level	0.032	0.013	−0.025
Marital status	−0.049	−0.111**	−0.060
R^2	7.5 %	2.2 %	4.6 %
Step 2			
Age of adoption	0.208***	0.028	−0.021
ΔR^2	5 %	0 %	0 %
Total R^2	12.5 %	2.2 %	4.6 %

$* \ p < 0.05, \ ** \ p < 0.01, \ *** \ p < 0.001$

time spent in the adoptive family, the lower the level of ADHD symptoms. The variance components indicated that 7.5 % of the total variance was explained in this first model by the five adoptee control variables. The inclusion of the age of adoption in the second step showed that this variable significantly predicted the level of ADHD symptoms over and above the adoptee control variables. The variance components indicated that 12.5 % of the total variance was explained in this second model (5 % more than in the first model).

The specificity of the relation between the age of adoption and the level of ADHD symptoms was tested in two similar hierarchical regression analyses with the residuals of both externalizing and internalizing behavior as outcomes. In the first step, externalizing behavior was predicted by age and marital status. The level of externalization was seen to increase with the age and adolescents in alternative marital situations displayed higher levels of externalizing behavior than those living with the adoptive parents together. The variance components indicated that 2.2 % of the total variance was explained in this first model by the adoptee control variables. In the second step, the age of adoption was not significantly related to externalizing behavior and no significant additional variance was added to the first model.

In the first step, internalizing behavior was predicted by gender and by length of time in adoptive family. The longer the time spent in the adoptive family, the lower the level of internalization. In addition, girls displayed higher levels of internalizing behavior than boys. The variance components indicated that 4.6 % of the total variance was explained in this first model by the adoptee control

variables. In the second step, the age of adoption was not significantly related to internalizing behavior and no significant additional variance was added to the first model.

Multilevel analysis

Before modeling our main research question for the level of ADHD among adolescents, we ran an unconditional model (with no predictors) to see which part of the total variation was attributable to the adoptee and the country levels. The results from the random section indicated both individual and cultural significant variability and showed that it was appropriate to examine the influence of several predictors of the level of ADHD symptoms in conditional models.

A first conditional model with adoptee control variables was analyzed to see which part of the total variation was due to the adoptee control variables, i.e. age, gender, length of time in adoptive family, parents' educational level and marital status. Significant effects of the length of time in adoptive family and gender were found. The longer the time spent in the adoptive family, the lower the level of ADHD symptoms. In addition, boys displayed higher levels of ADHD symptoms than girls. The variance components indicated that 5.31 % of the total variance was explained by the model.

A second conditional model was analyzed to test our main hypothesis, i.e. the specific effect of the age of adoption on the level of ADHD symptoms, controlling for the adoptee variables (age, gender, length of time in adoptive family, parents' educational level and marital status), and taking into consideration the variance at the adoptee and country levels.

Does the age of adoption predict the level of ADHD symptoms in adolescence across different groups of adoptees? The data presented in Table 2 suggest that the answer is yes: a higher age of adoption was significantly related to a higher level of ADHD symptoms. The significant coefficient meant that each additional month in the age of adoption resulted in an increase of 0.020 in the level of ADHD symptoms. The variance components indicated that 8.82 % (3.51 % more than in the first conditional model) of the total variance was explained by the model.

The third conditional model was analyzed as a full model with adoptee variables at level 1 and country variables at level 2. It investigated the extent to which the age of adoption influenced the adoptees' level of ADHD symptoms, controlling simultaneously for adoptee and country characteristics and taking into account the variance at the adoptee and country levels. The analysis of the third conditional model revealed that, when other adoptee and country characteristics were controlled for, the age of adoption remained significantly related to the level of

Table 2 Multilevel unconditional model, conditional models with adoptee-level and country-level variables

Parameter	Estimate	SE	Estimate	SE	Estimate	SE	Estimate	SE
Fixed								
Intercept	3.960***	(0.31)	4.909**	(1.66)	5.466**	(1.69)	6.173**	(1.89)
Adoptee variables								
Age			−0.098	(0.11)	−0.164	(0.12)	-0.164	(0.11)
Gender			0.509***	(0.12)	0.512***	(0.12)	0.501***	(0.12)
Length of time in adoptive family			−0.314**	(0.10)	−0.366**	(0.11)	−0.313**	(0.12)
Educational level			0.140	(0.17)	0.121	(0.10)	0.146	(0.10)
Marital status			−0.134	(0.22)	−0.158	(0.22)	−0.139	(0.22)
Age of adoption					0.020**	(0.00)	0.021***	(0.01)
Country variables								
HuDI in country of origin							−0.239	(0.28)
WHO ranking in country of origin							−0.013*	(0.01)
Individualistic value in adoptive country							0.001	(0.01)
WHO ranking in adoptive country							−0.027*	(0.01)
Random								
Variance components								
Adoptee-level	82.66 %		81.51 %		81.65 %		81.54 %	
Country-level	17.33 %		13.18 %		9.53 %		8.53 %	
Explained			5.31 %		8.82 %		9.93 %	
Deviance	3,290.68		3,280.58		3,284.65		3,299.27	

* $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$

ADHD symptoms. Moreover, the WHO rankings of both the country of origin and the country of adoption were significantly related to the level of ADHD symptoms. The results suggest that, when adoptee and other country characteristics were controlled for, adolescents from the groups at level 2 with a higher ranking in both their country of origin and their country of adoption displayed lower levels of ADHD symptoms. In other words, adolescents displayed lower levels of ADHD symptoms if they came from a country with a better health system and if they had been adopted in a country with a better health system. The significant coefficient meant that an improvement of one position in the WHO ranking resulted in a decrease in the level of ADHD symptoms of 0.013 for the country of origin and 0.027 for the country of adoption. The introduction of the country variables accounted for about 1.11 % of additional explained variance.

The results are displayed in Table 2 for the models.

Discussion

The main purpose of the current research was to study the predictive role of early attachment deprivation on the level of ADHD symptoms among adopted adolescents. The impact of the age of adoption was treated as a measure of the duration of exposure to deprivation. It was tested after

controlling for the influence of adoptee (age, gender, length of time in adoptive family, parents' educational level as a proxy of SES, and marital status) and country factors (social and economic development and health services in the country of origin, and individualistic values and health services in the country of adoption).

Our results support the main hypothesis that attachment deprivation predicts the level of ADHD symptoms, taking into consideration several adoptee and country variables, as well as the interdependence between adolescents according to both their country of origin and their country of adoption. We found that higher ages of adoption predicted higher levels of ADHD symptoms in adolescents. This suggests that neglect in 1 month of life, i.e. the lack of stable care and nurturance which has an impact on the development of attachment relationships, contributes to an increase in the level of ADHD symptoms several years later. As suggested in earlier studies, attachment processes apparently contribute to the development of attention skills and of emotional and behavioral self-control. Children with early attachment deprivation are therefore at risk of exhibiting behavioral problems later on, in particular ADHD symptoms [5, 11, 71]. It should be noted that the adoptees in the current study may have experienced deprivation in a broader sense, not only having missed out on stable attachment relationships but also having lacked essential ingredients needed for healthy physical,

emotional and cognitive development (e.g. lack of stimulation, toys, and learning materials).

Furthermore, our results support the hypothesis that ADHD symptoms are a characteristic outcome of early deprivation [31, 60], whereas the duration of exposure to deprivation was not significantly related to either externalizing or internalizing behavior. Our results corroborate the assumption that early deprivation as experienced by adoptees in their 1 month of life, i.e. lack of assistance with affect regulation in early childhood, lack of reciprocity, lack of empathetic emotional mirroring by the caregiver and associated emotional containment, is associated with poor self-regulation and attention problems, and that this association is more robust than the findings for other behavioral or emotional outcomes. This relation may be explained by the importance of sensitive and responsive interactions in the caregiver–child dyad for the development of a secure relationship in which the child learns to regulate his/her own affect and behavior [22, 39].

Beside these hypotheses, other significant effects of control variables have been found. For individual factors, as expected, ADHD symptoms were at a higher level in boys than in girls. This main effect confirms the results from worldwide prevalence studies [46]. In addition, a lower level of ADHD symptoms was predicted by the length of time in the adoptive family. In other words, additional years spent in their adoptive family setting can be regarded as helping adoptees to recover. Finally, as suggested in the previous developmental studies [33], a reduction in ADHD symptomatology with age was found in our sample, but only in the classical hierarchical regression analysis and not when the variance at the adoptee and country levels was taken into account.

The absence of any effect of marital status or socio-economic status contradicts previous findings [17, 44, 52, 70]. However, it could be that a measure of the level of marital conflict would be more predictive of the level of ADHD symptoms in adolescents than a dichotomous classification of adoptive parents as either living together (first group) or living separately or a single adoptive mother (second group). Also, it could be that the range in educational level of the adoptive parents was not large enough to display significant relations with the level of ADHD symptoms. This range is somewhat limited because of the policy of selection of the adoptive families according to their socio-demographic characteristics.

The results displayed for the cultural factors were in line with those from previous research [3, 10, 34]. A significant effect was shown for the WHO ranking of both the country of origin and the country of adoption. This stresses the importance of the quality of the health services for children institutionalized prior to their adoption in their country of origin but also for these children after their adoption. This

point relates in particular to the system's responsiveness, which is the main factor that determines the country ranking; this makes sense in light of the theoretical background to attachment deprivation.

Although important from both clinical and research perspectives, this study is by no means definitive. A first important limitation in studies relying on adoption is the bias in the association between the origin of the children and the country of adoption. This is because individual countries have agreements on the adoption of children with certain countries rather than others. For example, all of the 37 Russian children had been adopted in Canada. Such a bias has implications with regard to both the number and the size of the level-2 cells in the analyses. A second limitation in studies on adoption in general as well as in the current study is the lack of qualitative information about the individual care and nurturance that children have actually received before adoption. The age of adoption is in most cases the only variable that can be used as a measure of the duration of exposure to early deprivation in care and nurturance. Although the age of adoption may serve as a rough, but effective proxy for considering effects of deprivation (see also [67]), the study may also reveal a whole range of health and other forms of deprivation as causal, and these may be part of the early lives of children before their adoption. Another alternative hypothesis adjusting to a different culture and family becomes more and more difficult as children grow older. A third limitation is that the current findings were based on parent information only and did not include teacher- or self-reports.

It should be noted that meta-analytical evidence has convincingly shown that adoption is a positive and effective intervention in adopted children's lives. Despite the experiences of deprivation, adoptees show catch-up growth in the domains of physical, social-emotional, and cognitive development, outperforming those children unfortunately left behind in institutional care [27]. Adoptees also display more behavior problems (including ADHD) than their non-adopted counterparts, but this concerns a minority of adoptees. The large majority function well, and much better than might be expected based on their background of deprivation [28].

In conclusion, in a large cross-national study including 641 adopted adolescents in five countries we tested the contribution of early deprivation to later ADHD symptoms and found that the age of adoption significantly predicted the level of ADHD symptoms, with increasing ages of adoption predicting higher levels of ADHD. This outcome suggests that deprivation of stable and sensitive care in infancy may have long-lasting consequences for children's development. Implications for policy and practice are that adoptive parents should be supported to help their children recover from experiences of deprivation and that children

without parental care should be placed in foster or adoptive families as early as possible to avoid or prevent experiences of institutional deprivation.

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