



Trends in the dose-response relationship between adverse childhood experiences and maladaptive metacognitive beliefs: A cross-sectional study

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ABSTRACT

Background: Since the publication of the major research on adverse childhood experiences (ACE) at the turn of the millennium, our knowledge about the prevalence and physical and mental consequences of childhood adversities has increased substantially. In parallel, research on metacognition, which plays an important role in understanding our mental functioning, has also been on the rise. Although the adverse effects of ACEs on mental processes and the role of metacognitive deficits in the development of mental disorders are widely known, hardly any research into the interaction between these two areas has been conducted; this is what triggered our investigation.

Methods: Our research was carried out as a cross-sectional study on a sample of 304 members of the general population. We measured ACEs with the 10-item Adverse Childhood Experiences Questionnaire and maladaptive metacognitions—positive and negative metacognitive beliefs, cognitive confidence, cognitive self-consciousness, and need to control thoughts—using the Meta-Cognitions Questionnaire.

The closeness of the relationship between the ACE score and metacognitions was measured using Pearson's linear correlation coefficient, while the association of ACE accumulation with metacognitive beliefs was assessed using generalized linear models.

Results: The most common ACE in our sample turned out to be emotional neglect (44.74%). All the examined maladaptive metacognitive beliefs correlate mildly to moderately with the number of suffered ACEs ($r = 0.13$ – 0.34), with an increase in the ACE score leading to a rise in the salience of maladaptive metacognitive beliefs. Moreover, a dose-response relationship was seen between increases in ACE scores and the overall values of metacognition, negative metacognitive beliefs, and the maladaptive metacognitive belief of the need to control thoughts.

Conclusions: Our results suggest that the more ACEs were experienced in childhood, the more pronounced the dysfunctional metacognitive beliefs are. Therefore, our findings emphasize the importance of further research into the topic.

1. Introduction

Felitti and colleagues [1] were the first to define the conceptual framework of adverse childhood experiences (ACEs), which include emotional, physical, and sexual abuse, emotional and physical neglect within the family, and the effects of dysfunctional family circumstances (such as parental separation or divorce, household physical violence, household substance abuse, household mental illness, and incarcerated household member).

Since the first pioneering study by Felitti and colleagues, numerous results have confirmed the severe consequences of adverse childhood experiences, which may persist into adulthood or throughout an individual's whole life [2].

One of the important findings by Felitti and colleagues [1] is that ACEs represent not only a crucial risk factor for severe physical conditions, but a dose-response relationship can be found between these adversities and health conditions. Recent research has confirmed that ACEs also show a dose-response relationship with psychological symptoms

Abbreviations: ACE, adverse childhood experiences; MCQ, Meta-Cognitions Questionnaire; CC, Cognitive confidence; POS, Positive beliefs; CSC, Cognitive self-consciousness; NEG, Negative beliefs; NC, Need to control thoughts.

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[3,4].

Multiple neurobiological, hormonal and immune dysfunctions caused by chronic traumatic childhood experiences have been shown to exert an impact on the development of trauma-related disorders by mediating the pathogenic effects of adverse experiences on several organ systems [5,6]. The well-documented outcome of enduring adversities is the volumetric and functional divergence observed in individual brain structures and networks [7]. Constant feelings of threat, unmanageable emotional states and coping skills deficits result in a near-constant state of stress, which also affects immune function [8–10]. Prolonged adverse childhood experiences can cause severe attachment difficulties [11], emotional and behavioral dysregulation, health-damaging activities, as well as cognitive, social, and emotional impairments, which may contribute to the development of mental and somatic disorders [12,13].

In their review, Aafjes-van Doorn, Kamsteeg and Silberschatz [14] synthesized the results of 98 studies, and demonstrated that cognitive factors play a mediating role between adverse childhood experiences and adult psychopathology. The cognitive mediators they identified were maladaptive cognitive schemas, as well as maladaptive attributions and beliefs.

Apart from the well-known maladaptive cognitive schemas and attributions, it is pertinent to consider a further cognitive factor, namely metacognition. The term metacognition was first described by Flavell [15], who described it as thinking about our thinking, or cognition about our cognition. Nelson and Narens [16] further specified the term metacognition, and suggested that metacognition performs monitoring and control tasks over our cognitive functioning.

Subsequent research has shown that metacognition can be considered an umbrella concept, as it serves a monitoring and controlling function not only over clearly definable cognitive processes but also over complex psychological functions [17,18]. Metacognition involves the monitoring and controlling of our intentions, thoughts, and emotions, and the synthesizing and integrating process through which intentions, thoughts, beliefs, and emotions are integrated into larger complexes within contexts or into complex representations of self and others. This complex concept is referred to in the literature as Lysaker's integrative metacognitive model [19].

According to Wells and Matthews [20], properly functioning self-regulatory operations lead to modifications in cognitive processing or even the maintenance of dysfunctional processing. This means that metacognitive operations are necessary to regulate our cognitive functioning, including our cognitive beliefs.

Wells and colleagues [21,22] consider the extended processing of negative information to be a coping strategy that can lead to the development of psychological disorders. The development and persistence of psychological disorders are underpinned by beliefs that mold our thinking and coping mechanisms. These contain significant metacognitive components, identified as positive (e.g., "Worrying is useful, it helps prepare for the worst.") or negative metacognitive beliefs (e.g., "Thoughts are uncontrollable and dangerous."), cognitive confidence (e.g., "I cannot trust my memory. "), cognitive self-consciousness (e.g., "I closely monitor the way my mind works. ") and need to control thoughts (e.g., "Thoughts should be controlled. "), which underlie the development and persistence of disorders. These maladaptive metacognitive beliefs lead to inappropriate emotional, cognitive, and behavioral responses [22] and indicate inadequacies in metacognitive monitoring and control processes.

The above-mentioned insights into metacognition suggest that maladaptive metacognitive beliefs may contribute to the long-lasting cognitive, emotional, and behavioral consequences of ACEs. In this regard, Myers and Wells [21] argue that if the perpetrator is the victim's caregiver, the child will not be able to acquire adequate self-regulation and self-control and will develop beliefs about lack of personal control. Maladaptive beliefs about the uncontrollability and dangerousness of their own mental contents (e.g., negative beliefs or need to control

thoughts) contribute to the child's emotional vulnerability. In addition, it can be assumed that maladaptive metacognitive beliefs are reflected in trauma survivors' attempts to control or suppress thoughts and memories [23] (need to control thoughts), the lack of confidence in their cognitive functioning due to uncontrollable intrusions of traumatic memories and thoughts (cognitive self-confidence) [24,25], or the belief of dangerousness of thoughts and memory contents (negative metacognitive beliefs) [26,27]. Presumably, these associations may be relevant not only in the context of traumatic experiences, but that of all ACEs.

So far, only a few studies have examined the relationship between ACEs and metacognition. A study in the general population found that adverse childhood experiences result in impaired metacognitive differentiation and integration skills, and significantly higher levels of anxiety in the ACE group. The authors investigated the absence or presence of sexual and physical abuse and neglect using a structured interview. Metacognitive processing was investigated with the help of the Metacognition Assessment Interview. The interview interprets metacognition as the ability to understand and interpret one's and others' complex mental state and reflect on them. In this sense, differentiation means the understanding of the representational nature of mental states and the recognition of the differences of internal and external reality. Metacognitive integraton skills represent the ability to identify and reflect upon different mental states to maintain coherence. [28]. The results of a study conducted by Taylor and colleagues [29] among university students clearly demonstrated a significant indirect effect of adverse childhood experiences (abuse and neglect, and dysfunctional family circumstances as well) on the onset of anxiety symptoms mediated by attention control. Individual metacognitive beliefs were not investigated in this study. The mediating role of metacognition has also been confirmed in a non-clinical population by Myers and Wells [21] in their study of early emotional, physical, and sexual abuse, and emotional dysregulation observed later. According to their results, it was only emotional abuse that correlated with a maladaptive metacognitive belief, namely emotional abuse, and showed a link with all of the maladaptive metacognitive beliefs mentioned above, except for the positive metacognitive beliefs. These results reveal that negative beliefs mediate the relationship between emotional abuse and negative affect.

Few assessment tools of metacognition have been developed to date, of which the Meta-Cognitions Questionnaire measures maladaptive metacognitive beliefs [17]. Interview-based measures such as the Metacognitive Assessment Scale [30,31] or the Metacognition Assessment Interview [32] assess the complex reflective nature of metacognition in terms of self and object representations.

The first instrument designed to measure ACEs was the Adverse Childhood Experiences (ACE) Questionnaire [1], which assesses physical, emotional, sexual abuse, and household dysfunction. Since its development several versions of the questionnaire were created to measure ACEs [33], including the Adverse Childhood Experiences Abuse Short Form ACE-ASF [34], ACE International Questionnaire ACE-IQ [35], and the 10-item Adverse Childhood Experiences Questionnaire (ACE-10) [21]. The 10-item version of the ACE questionnaire (ACE-10) assesses the exposure to all 10 types of ACEs (abuse, neglect, and five household dysfunctions) with 10 single-item questions, therefore, it is an appropriate tool for screening [36–38].

To the best of our knowledge, no studies have been conducted to date that would simultaneously investigate the 10 most relevant ACEs and the relevant types of maladaptive metacognitive beliefs, and their relationship. There is no data on whether considering early dysfunctional family circumstances, beyond abuse and neglect, provides additional information on maladaptive metacognitive beliefs. Moreover, the question of whether a dose-response relationship can be detected between ACEs and metacognition has not been addressed by researchers either.

Our present study is embedded in a larger study investigating the relationship between ACEs, metacognition, and psychological

vulnerability. In the first phase of our study, we explored what impact adverse childhood experiences have on the development of metacognitive beliefs, and whether a dose-response relationship can be identified between adverse childhood experiences and certain maladaptive metacognitive beliefs. In this paper, we aim to focus on these research questions. The results of the further stages of the study will be reported elsewhere, which is justified by the large amount of data and results.

2. Methods

2.1. Sampling and data collection

We tested an accessibility, non-probability sample recruited online using the snowball sampling method. We published the invitation to participate in the study on social media platforms, and to avoid bias we made sure that these platforms were neutral and not related to the topics we were investigating. Members of the general population aged 18 and over were enrolled into the study. As adverse events are usually covert and most such cases do not come to light, there was no need for further inclusion and exclusion criteria to avoid bias resulting from creating a sample with under- or over-representation of ACEs, as well as to obtain a sample that most closely approximates the average population.

2.2. Ethics

As our research involves sensitive topics, anonymity and voluntariness were ensured for the protection of personal rights. The individual indicating their willingness to participate in the study could access the assessment tools via an online interface after giving informed consent complied and handled in harmony with current data protection guidelines. The data were stored in a password-protected manner, inaccessible to third parties.

Participants were allowed to indicate their need for psychological support, if necessary, or if they felt upset while completing the tests. However, no participant took advantage of this opportunity.

The study was conducted with the ethical approval of the Regional and Institutional Ethics Committee of the University of Debrecen (DE RKEB/IKEB 6205–2022), observing the principles of the Declaration of Helsinki.

2.3. Measures

Study participants completed a demographic questionnaire, an assessment tool for metacognitions, as well as a questionnaire assessing adverse childhood experiences.

The *demographic questionnaire* consisted of questions compiled by the authors, and it included questions on the age, gender, marital status, educational attainment, and occupational status of the participants.

The *30-item version of the Meta-Cognitions Questionnaire* (MCQ) [22,39] was used to assess the participants' beliefs about their thinking, i.e., metacognitions. This questionnaire contains 30 statements regarding beliefs about one's own thinking. Participants can indicate on a four-point Likert scale how much they consider each item to be typical of themselves. The responses are grouped into five subscales representing five maladaptive metacognitive beliefs:

- MCQ CC: Cognitive confidence (lack of confidence in attention and memory);
- MCQ POS: Positive beliefs (positive beliefs about worry);
- MCQ CSC: Cognitive self-consciousness (the tendency to focus attention on thought processes);
- MCQ NEG: Negative beliefs or Uncontrollability/danger (negative beliefs about the uncontrollability and dangerousness of worry);
- MCQ NC: Need to control thoughts (negative beliefs concerning the consequences of not controlling thoughts)

The sum of the scores of the subscales account for the total score for the MCQ-30.

A maximum of 24 points can be achieved on each subscale. The maximum total score available is 120, which indicates the most pronounced maladaptive metacognitive beliefs.

The *Adverse Childhood Experiences Questionnaire 10-item version (ACE-10)* is a self-report retrospective questionnaire [36–38] assessing 10 types of intrafamilial ACEs, including: five types of maltreatment (emotional, physical, sexual abuse, physical, and emotional neglect), and five types of dysfunctional family environment (parental separation/divorce, witnessing violent treatment of mother, household substance abuse, household mental illness, incarcerated household member). The questionnaire consists of 10 questions requiring a yes/no answer. To reduce the subjectivity of perception, the survey investigates common and/or severe behavioral patterns by providing concrete examples. Based on the number of types of ACEs, an ACE score between 0 and 10 is calculated. It is a severity index suggesting the accumulation of ACEs, in other words, how many types of adversity a person experienced in their childhood.

2.4. Statistical analysis

The analysis was performed using IBM SPSS Statistics version 25 (IBM, Armonk, NY, USA). In the analysis, the significance level was set at a uniform 5%. Due to the sample size, the normality of the statistics calculated from the sample was assumed based on the central limit theorem, and thus not tested separately [40]. The closeness of the relationship between ACE score and variables of metacognition was measured using Pearson's linear correlation coefficient [41], as the analysis was of scale-type variables. When we investigated the dose-response relationship between ACE scores and metacognition while controlling for basic demographics, ACE scores were grouped into five categories with 0; 1; 2; 3; 4 or more ACEs. Reducing the response categories is a common practice in the literature [1] and was useful in this case because there were few respondents who reported >4 ACEs, and combining them served to provide a sufficient sample size in each category. The association between ACE accumulation and metacognitive beliefs was assessed using generalized linear models. The process helps to evaluate the dose-response relationship that is, how the gradual accumulation of ACEs relates to the level of maladaptive metacognitions, while allowing controlling for multicategorical confounders. All models were adjusted to age, gender, and educational attainment. Post-test analysis was carried out using the adjusted Wald test.

3. Results

The total sample consisted of 304 subjects; 256 of whom (84.2%) identified themselves as female, and 48 (15.8%) as male. Half of the sample ($n = 158$, 52.0%) was married or lives in a cohabiting relationship. More than one-third of the respondents ($n = 116$; 38.2%) had a college or university degree, and 41.1% ($n = 125$) had a high school certificate. Most of them were employed ($n = 196$; 64.5%). The mean age of the whole sample was 34.1 years ($SD = 13.28$, range: 18–70). Detailed demographic data are presented in [Table 1](#).

On average, respondents experienced 2.8 ($SD = 2.39$) adverse childhood experiences. The most common adverse experience was emotional neglect (44.74%) and the least common was having an incarcerated household member (13.82%). Almost a fifth of the subjects had no adverse childhood experiences at all, whereas 37.83% reported four or more types of childhood adverse experiences ([Table 2](#)). As the table reveals, the number of people with more adverse experiences decreases as adversities accumulate.

In the Meta-Cognitions Questionnaire, subjects scored an average of 60.43 ($SD = 17.72$) out of the maximum achievable 120 points. The average results of each scale are as follows: Positive beliefs = 9.53 ($SD =$

Table 1
Demographic characteristics of the sample.

		n	%
Gender	Female	256	84.21
	Male	48	15.80
Marital status	Single	122	40.13
	Married/in a relationship	158	51.97
	Divorced	18	5.92
	Widowed	5	1.64
	NA	1	0.33
Educational attainment	Elementary or vocational school	63	20.72
	High school certificate	125	41.12
	College or university degree	116	38.16
	NA	1	0.33
Occupational status	Unemployed	16	5.26
	Employed	196	64.47
	Student	66	21.71
	Rehabilitation contribution/maternity allowance	16	5.26
	Retired	8	2.63
	NA	2	0.66

NA: not answered.

Table 2
Distribution of the number of adverse childhood experiences in the sample.

Exposure to ACE categories	n(%)
Emotional abuse	121(39.80)
Physical abuse	68(22.37)
Sexual abuse	57(18.75)
Emotional neglect	136(44.74)
Physical neglect	42(13.82)
Parental separation/divorce	108(35.53)
Household physical violence	40(13.16)
Household substance abuse	120(39.47)
Household mental illness	132(43.42)
Incarcerated household member	42(13.82)
ACE score	n(%)
0	60(19.73)
1	54(17.76)
2	38(12.50)
3	37(12.17)
4	41(13.49)
5	30(9.87)
6	18(5.91)
7	11(3.62)
8	9(2.96)
9	6(1.97)
10	0(0)
≥4	115(37.83)

ACE: adverse childhood experiences.

13.56); Negative beliefs = 13.29 (SD = 5.42); Cognitive confidence = 11.47 (SD = 4.45); Need to control thoughts = 12.28 (SD = 4.29); Cognitive self-consciousness = 14.81 (SD = 4.46) out of the 24 points achievable on each subscale.

All of the assessed maladaptive metacognitive belief scales correlate positively with the number of adverse experiences suffered in childhood (Table 3). The consistent positive correlation suggests that a growing number of adverse childhood experience types is generally associated with more pronounced maladaptive metacognitions, separately for each type and overall for the MCQ total score. The correlations are weak to moderate.

Pearson correlation.

In the next step, we investigated whether a dose-response relationship could be proved between the accumulation of the ACEs and the scores for particular metacognitive beliefs, and metacognitive beliefs in general.

Table 4 shows that ACE accumulation significantly predicted an

Table 3
Correlation between the number of adverse childhood experiences and maladaptive metacognitive beliefs in the sample.

Cumulative ACE score	r	p
MCQ_POS	0.13	0.023
MCQ_NEG	0.34	<0.001
MCQ_CC	0.31	<0.001
MCQ_NC	0.30	<0.001
MCQ_CSC	0.14	0.013
MCQ_Total	0.32	<0.001

ACE: adverse childhood experiences; MCQ: Meta-Cognitions Questionnaire; POS: positive beliefs; NEG: negative beliefs; CC: cognitive confidence; NC: need to control thoughts; CSC: cognitive self-consciousness.

increased presence of all metacognitive beliefs measured separately and overall. Respondents with 1, 2, 3, 4 or more ACEs reported significantly more marked negative beliefs (MCQ_NEG), need to control thoughts (MCQ_NC), and overall maladaptive metacognitive beliefs (MCQ_Total) than those with 0 ACEs. Similarly, the tendency to lack cognitive confidence (MCQ_CC) was more common among participants with 2, 3, 4 or more ACEs compared to individuals reporting 0 ACEs. Experiencing 3, 4 or more ACEs significantly predicted higher levels of cognitive self-consciousness (MCQ_CSC), compared to experiencing 0 ACEs. Those who reported 4 or more ACEs held significantly more positive metacognitive beliefs (MCQ_POS) than participants experiencing no ACEs. All models were significant. Our results do not confirm a linear dose-response relationship except for negative maladaptive metacognitive beliefs, need for control thoughts, and maladaptive metacognitive beliefs in general. In the rest of the metacognitive beliefs, a trend could be detected.

4. Discussion

Our results on the distribution of ACEs are consistent with the findings of previous studies, although in some cases they are at the upper end of the prevalence range of ACEs found to date [42,43]. This may be explained by the fact that even if the prevalence of different forms of abuse is high worldwide, researchers have measured higher rates in the Central and Eastern European region compared to the Western European region [44,45].

The reason for high prevalence rates may also be that the questionnaires could be completed online and anonymously, resulting in an increased willingness to report on this sensitive topic [46]. Alternatively, it is possible that no matter how much we tried to share the questionnaires on neutral platforms, still a higher proportion of individuals affected by the topic to be investigated may have responded to the survey call [47].

Similar to the results of Riccardi et al. [28], our findings confirmed the association between adverse childhood experiences and metacognitive functioning. According to our results, negative metacognitive beliefs (MCQ NEG), the lack of confidence in memory and attention (MCQ CC), and the need to control thoughts (MCQ NC) showed the most pronounced correlation with the severity index of early adversities. These findings are consistent with the efforts of trauma survivors to control trauma-related thoughts and memories [23]. However, it has been proved that the attempts to control negative thoughts or even the attempts to suppress them may have paradoxical results: they can lead to an increase in the intensity and frequency of unwanted thoughts and memory contents [48]. According to other findings, repressing thoughts and memories can make the recollection of memory contents impossible [49], which means that traumatic experiences remain unintegrated and can contribute to the development of symptoms of trauma-related disorders (e.g., intrusive thought or memory contents, dissociation, affective symptoms) [23,50,51]. The loss of recollections of memory contents or even the emergence of unwanted thoughts, memories, and worry in trauma survivors supports, in turn, the development of maladaptive

Table 4

Associations between the accumulation of adverse childhood experiences (ACEs) and metacognitive beliefs separately and overall.

	MCQ POS	MCQ NEG	MCQ CC	MCQ NC	MCQ CSC	MCQ Total
	B (95%CI)	B (95%CI)	B (95%CI)	B (95%CI)	B (95%CI)	B (95%CI)
ACE score (ref.: 0)						
1	1.04 (-0.32–2.40)	2.36 (0.36–4.11)*	1.07 (-0.47–2.61)	1.94 (0.43–3.44)*	0.96 (-0.65–2.57)	6.74 (0.69–12.8)*
2	0.96 (-0.55–2.46)	2.86 (0.79–4.92)**	2.49 (0.76–4.19)**	2.74 (1.07–4.41)**	1.57 (-0.19–3.34)	10.99 (4.27–17.71)**
3	1.32 (-0.19–2.83)	3.31 (1.23–5.39)**	1.94 (0.24–3.65)*	3.19 (1.52–4.86)***	2.99 (1.22–4.78)**	13.84 (7.07–20.61)***
4 or more	1.79 (0.63–2.96)**	5.08 (3.47–6.68)***	4.08 (2.76–5.40)***	3.90 (2.61–5.19)***	2.21 (0.84–3.58)**	17.11 (11.92–22.30)***

ACE: adverse childhood experiences; MCQ: Meta-Cognitions Questionnaire; POS: positive beliefs; NEG: negative beliefs; CC: cognitive confidence; NC: need to control thoughts; CSC: cognitive self-consciousness.

Generalized linear models, adjusted for age, gender, and educational attainment.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

metacognitions such as mistrust of one's own attention and memory functions (MCQ CC) [24,25], negative beliefs concerning the consequences of not controlling thoughts (MCQ NC) or beliefs about the uncontrollability/dangerous nature of thoughts (MCQ NEG) [26,27].

The most important finding of our present study is that maladaptive metacognitive beliefs become more pronounced with the accumulation of adverse childhood experiences. Our results revealed a clear dose-response phenomenon between total scores on maladaptive metacognitive beliefs and the number of suffered ACEs. Also, a dose-response relationship could be detected between scores on negative maladaptive metacognitive beliefs (MCQ NEG), the metacognitive bias of need-to-control-thoughts (MCQ NC), and the number of ACEs suffered. For the rest of the examined metacognitive biases, only a trend towards a dose-response relationship was observed. The dose-response effect seen in our present study suggests that more severely traumatized individuals exhibit more rigid thinking distorted by biases (negative beliefs about the dangerousness of one's thoughts) and more inadequate metacognitive coping strategies (increased tendency to control thoughts).

The importance of these results is emphasized by the fact that adverse childhood experiences also show a dose-response effect with psychological symptoms [3,4]. In addition, the association of deficits in metacognitive functioning with a wide range of psychological disorders and symptoms has been demonstrated in numerous studies [52,53]. Also, a few results have been gathered on the mediating role of metacognition between ACEs and psychological symptoms [21,23,29]. This suggests that more adverse events experienced in childhood result in more inadequate metacognitive functioning, which may contribute to the development of trauma-related symptoms and disorders.

Even if our results cannot support the following theoretical conclusions, it may be worth extending the framework of Wells' and Matthews' [20] metacognitive theory and also take into account Lysaker's integrative metacognitive model [54,55] which shed additional light onto our results. According to this theory, metacognition monitors and controls not only our discrete cognitive processes but also our beliefs and complex representations, thus enabling us to form complex representations of ourselves, others, and the world. Looking at our results thorough this theory, it seems that more serious childhood traumatization coexists with more serious inadequacies of the metacognitive monitoring and control system. Flawed metacognitive monitoring and control do not allow the correction of maladaptive beliefs, which also affects the person's self-representations and object-representations (see the negative self-representations of traumatized persons and their images of the dangerous other). Also, it adversely affects the person's integrative capacities [28], which can manifest in the affectedness of the personality structure [56]. Moreover, metacognitive failures make it impossible to integrate traumatic memory content and will, in turn, mold the understanding of events in the external and internal world in a way that can lead to the emergence of trauma-related symptoms [21].

Along these lines, metacognitive features may represent an important target in the research on the consequences of ACEs.

One limitation of our research is the female predominance in the

sample. Although in all the previous studies, women reported more ACEs, in the present study the information obtained mainly from females reflects an even greater willingness of women to cooperate. It would therefore be worthwhile to expand the sample to include more male respondents.

While the invitation to participate stated that we were looking for respondents without a psychiatric diagnosis, the nature of the data collection (online anonymous survey, snowball sampling) does not exclude the possibility that a few people with mental disorders may have been included in the sample. A possible measure to address this could be the inclusion of screening questions for mental health or psychiatric diagnoses in the future.

The cross-sectional design of our study may limit the interpretability of data. The relationship between ACEs and metacognition has not yet been investigated in a longitudinal research design. Future studies in this direction may provide additional valuable information. Additionally, the assessment of ACEs and the MCQ relied on self-reporting, which may allow for bias. Although respondents from a wide range of educational attainment were included, the sample cannot be considered representative. At the same time, we consider our sample to be suitable for capturing the current situation in large sections of society.

A further limitation of our study is the lack of investigating the potential mediating or moderating factors between ACEs and metacognitive beliefs. Alongside basic demographic characteristics (e.g., gender or level of education), it would be important for future research to investigate possible mediating and moderating factors such as volumetric and functional alteration of brain structures [7,8], coping skills, emotional dysregulation [6,10,12] neurocognitive and social cognitive functions [9] or as Liotti and Prunetti [11] suggest, attachment style.

5. Conclusion

Our results showed that the most common ACE in the sample was emotional neglect, which is consistent with previous research. The amount of adverse childhood experiences correlated mildly to moderately with all the examined maladaptive metacognitions. Our most important finding is that the experienced ACEs also showed a dose-response relationship with metacognitions, in a way similar to physical and mental symptoms. This finding highlights the importance of further research in the topic.

Ethics approval and consent to participate

The study was conducted with the ethical approval of the Regional and Institutional Ethics Committee of the University of Debrecen (DE RKEB/IKEB 6205–2022), observing the principles of the Declaration of Helsinki. All participants signed an informed consent form.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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CRediT authorship contribution statement

Dorottya Horváth: Writing – original draft, Investigation, Formal analysis, Data curation, Conceptualization. **Beáta Kovács-Tóth:** Writing – original draft, Methodology, Formal analysis. **Barnabás Oláh:** Writing – original draft, Formal analysis. **Zita Fekete:** Writing – original draft, Supervision, Investigation, Formal analysis, Data curation, Conceptualization, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no competing interests.

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