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Psychological treatments for pediatric headache

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Headache is the most common pain problem in children and adolescents and in a considerable proportion, a source of suffering and disability. Medical intervention mainly relies on abortive pharmacological agents (analgesics and antimigraine drugs). Psychological therapies aim at the prevention of headache episodes and the modifications of cognitive–emotional and –behavioral processes influencing pain. Three main forms of therapy have been evaluated in randomized controlled trials and reviewed in meta-analyses: relaxation training, biofeedback and multimodal cognitive–behavior therapy. So far there is only scarce evidence on hypnosis and acceptance and commitment therapy, though they seem to be promising. Evidence demonstrates that psychological therapies are efficacious and that clinically relevant improvement is found in approximately 70% of the treated children at follow-up examination. Future research has to focus on mechanisms of change, and has to extend its view of effects induced by therapy beyond headache improvement to indicators of quality of life.

KEYWORDS: biofeedback treatment • cognitive–behavioral therapy • efficacy • meta-analysis • migraine • pediatric headache • psychological treatment • relaxation training • tension-type

Headache syndromes & their classification

Tension-type headache (TTH) and migraine are the most important primary headache syndromes in children and adolescents – that is, headaches that are not secondary to any other medical issue or condition.

Migraine is an attack-like headache of a moderate-to-high intensity [1]. The quality of the pain is throbbing or pulsating. Unilateral location is required for diagnosis, but frontal pain location is more frequent in children [2]. For children, the critical duration of an attack required for diagnosis has been reduced to 2 h, compared with 4 h in adults. Headache is often accompanied by nausea or even vomiting, which makes it especially distressing. Any physical activity is supposed to aggravate pain. Photophobia and phonophobia present during the attack give cause to refrain from activities and avoid or withdraw from a stimulating environment. An aura (with a focus on visual disturbances) can precede the attack in children, but is less often found than in adults. Also, premonitory symptoms can show up (e.g., pale color of the face and feeling of tiredness). A family history of migraine is often reported. Similar to adults, the number of migraine attacks must exceed four before a diagnosis should be assigned. However, on the basis of empirical data

some researchers propose some modification of the criteria for pediatric migraine [2,3].

Tension type headache is more or less diagnosed by excluding migraine symptoms [1]. Thus, it is defined by low-to-moderate intensity and a dull quality of pain. TTH can be accompanied by nausea, but not by vomiting. Hypersensitivity to visual and acoustic stimuli, as well as the occurrence of an aura, excludes TTH. If TTH episodes occur on more than 15 days/month, it is classified as chronic, otherwise it is classified as episodic headache. Fortunately, chronic TTH is rare in children and adolescents.

It is not uncommon that an individual experiences both types of headaches – that is, migraine and TTH – at different times. However, it is notable that a rather larger number of pediatric headaches defy classification by the current system, which means that they do not fulfill the criteria for diagnosis of one or the other but show a ‘mixed’ picture of symptoms. The number of children with ‘mixed’ or not classifiable headaches can be higher than those with a distinct diagnosis of migraine or TTH. [4]. Furthermore, in regard to psychological therapy, headache diagnosis is of limited importance, since treatment procedures do not differ largely between headache syndromes and evidence of differential efficacy has not yet been presented.

Epidemiology & characteristics of pediatric headache

Various epidemiological studies documented that headache is a symptom of high prevalence in children and adolescents, and is the most common type of pain [5–8]. A recent study on German children between 9 and 14 years of age found the prevalence of migraine to be near 9%, TTH was diagnosed in approximately 18% [4] and more than 35% could not be classified as either one or the other. Recurrent headache on a weekly basis was reported by 17% of the youths, 40% described the pain as being ‘moderate’ to ‘strong’ on average. Most epidemiological studies indicate that girls from the age of 13 years onwards are more frequently afflicted by headache than boys, especially regarding recurrent headache [8,9]. Although the assumption that the onset of puberty is responsible for the preponderance of headache in girls seems plausible, a prospective study could not verify a distinct change in headache after the onset of menarche [10].

Parental reports indicated that on average, the first headache attack is experienced at the age of 7.5 years [8]. A long-term follow-up on pediatric migraine sufferers revealed that in more than 50% the disorder was maintained for over 40 years and thus presents itself as a long-time ‘companion’ of the individual [11]. Two Finnish studies corroborated the frequently stated opinion that the prevalence of pediatric headache has indeed increased – that is, nearly doubled – over the last 20 years [12,13].

While the majority of epidemiological studies report quite high prevalence rates of pediatric headache (63% [14]; 82% [15]), the sheer occurrence of headache is not to be confounded with ‘suffering’ from headache. In a recent epidemiological study from Germany, it was found that only 4.6% of the children and adolescents were moderately-to-severely impaired by their headache [16], which was corroborated by findings from Turkey [17]. By contrast, Hershey *et al.* reported that in a clinical sample, nearly 50% of 165 children applying for headache treatment were graded as moderately or severely disabled, which, of course, can be expected [18]. Based on data from population samples [16,19], it may be inferred that up to 5% of the youths experiencing headache are significantly disabled, indicating a considerable number of children who have to be considered for treatment.

There is some evidence that parents are rather reluctant to seek medical help for their headache-afflicted offspring, especially when an organic cause has been excluded. Less than 60% of the parents in the German study reported to have consulted a physician due to their children’s recurrent headache, and only approximately 55% stated to have ever used analgesics or anti-migraine medication [14]. Preventive medication was applied in only 6%. However, there was a sharp rise in medication utilization in adolescents.

The recently formulated guidelines for the treatment of pediatric migraine [20] concentrate on pharmacological interventions and recommend several agents for acute and preventive purposes (see [21,22] for efficacy of pharmacological agents in pediatric headache). The guidelines did not deal with TTH or mixed headache, nor did they discuss alternative options for treatment.

The purpose of this article is to acquaint neurologists, or other professionals interested in the treatment of pediatric headache, with different forms of psychological treatment and to present a synopsis of existing reviews and meta-analyses on their efficacy.

Psychological headache treatment

The biopsychosocial model of pain claims that chronic pain is influenced by cognitive–emotional, behavioral and social factors, which at least partly determine the maintenance of the disorder and especially pain-related disability and handicap [22]. Thus, the model emphasizes the view that cognitive styles of processing pain (e.g., catastrophizing [23] and fear of pain [24]) contribute to the sensory and affective experience of pain, and influence the grade of disability. This is also true for the feeling of helplessness and deficient self-efficacy beliefs [25]. Sickness behaviors as a mode of coping with pain by withdrawal and avoidance have been demonstrated to aggravate the pain syndrome [26].

Furthermore, there have been reports of pediatric headache being strongly associated with psychiatric morbidity (in more than 80%, see [27]). However, these large numbers have to be viewed with utmost caution, since, as Powers *et al.* [28] point out, the rules for classification of psychiatric disorders [27] were in most cases not adhered to. However, many studies documented higher levels of anxiety or depressive symptoms especially in girls afflicted by headache and a greater number of symptoms of hyperactivity, anger, aggressive behavior or conduct problems in boys [28,29]. Thus recurrent pains, such as headache, are often accompanied by cognitive–emotional and –behavioral symptoms, which might not exceed the threshold of psychopathology, but represent an additional burden laid upon the child.

Guidelines based on best empirical evidence often come to the conclusion that isolated medical interventions do not lead to sufficient alleviation of pain, not mentioning a decrease in disability (e.g., the European Guideline for the management of chronic nonspecific back pain [101]). A biopsychosocial treatment approach including or even emphasizing psychosocial interventions is not as emphatically recommended for the management of headache as it is with back pain or fibromyalgia, probably because acute treatment of migraine with pharmacological agents has been proved to be quite efficacious. Recent reviews demonstrated that they can also be used with children and adolescents, although they are not free of undesirable side effects [21,30].

Given the nonrefutable role that psychological factors play, experts in pediatric pain also advocate nondrug therapies (see [31,32]), especially from a preventive perspective. The German Migraine and Headache Society explicitly recommends the described psychological interventions for recurrent headaches [33] that are described in this section.

Three different treatment methods have been subjected to rigorous empirical testing: relaxation training (RT), biofeedback and cognitive–behavioral therapy (CBT). Hypnosis is often described as a powerful instrument for pain relief, but so far it has not been evaluated in randomized control designs for its efficacy regarding the improvement of headache and will not be discussed in detail here. However, based on empirical data from experimental

studies [34,35], it seems to offer quite a potential for headache treatment and should be subjected to an empirical examination in controlled trials in near future.

A new treatment approach in adult psychotherapy of pain, namely acceptance and commitment therapy, also promises favorable results in the treatment of pediatric headache, as the first study by Wicksell *et al.* demonstrates [36], where it proved to be more efficacious than traditional multidisciplinary treatment. Acceptance and commitment therapy, as an extension of traditional CBT, focuses on improving functioning and quality of life by increasing the patient's ability to act effectively in concordance with personal values in the presence of pain and distress [29].

Before examining the state of evidence regarding the three main intervention strategies, the treatment procedures, hypothetical mechanisms of action and objectives will be described briefly.

Relaxation training

Relaxation training – in most cases a child-adapted 'Progressive Relaxation' format (e.g., [37]) – was one of the first psychological interventions to be examined in pediatric headache management. The training concentrates on tensing and subsequently relaxing the muscles of the extremities, head, shoulder and back in a step-by-step manner. After prolonged training, a generalized relaxation response can be immediately self-induced and realized in nearly every situation. The objectives for the use of relaxation are the improvement of body awareness, a reduction of the general level of arousal, training of the ability to relax specific tense muscles, which could have triggered or reinforced pain, and the prevention, as well as the alleviation of the general stress response contributing to headache. Furthermore, RT is assumed to establish the cognition of 'self-efficacy' – that is, believing that one can control or influence mental and bodily functions. Self-efficacy is one of the most important mechanisms of change in psychotherapy [38].

Biofeedback treatment

Biofeedback treatment is based on the technical assessment of physiological functions (e.g., tension level of the frontalis muscle; [39]). The biological signals are transformed into perceptible signals, such as acoustic or visual stimuli, and fed back immediately to the patient. Thus, the patients are able to 'hear' or 'see' their actual body state. They are then instructed to modify the function in a direction that is assumed to prevent or alleviate pain (e.g., to relax the frontalis muscle). The immediate feedback is expected to start up a learning process. Self-control trials are always included into the training procedure to make the patient independent of the feedback in the long run.

If feedback is based on muscle tension [39] or peripheral skin temperature (usually measured at a finger) [40], the objective is to induce a state of 'relaxation'. Thermal biofeedback is conducted with the directive to increase temperature at the periphery and is often applied with concomitant relaxation self-instructions. Skin conductance measures (low conductance signalling relaxation) and EEG parameters (e.g., α -feedback) are rarely used in biofeedback treatment of headache. Only in vasomotor feedback (assessment of blood volume of the arteria temporalis indicating

dilatation or constriction of the vessel) [41], which is only used in migraine treatment, the targeted vasoconstriction is not part of a relaxation response, but corresponds to autonomic activation. The rationale behind this procedure is the assumption that central vasodilatation is a correlate of the painful phase during a migraine attack and that constriction might prevent a pain episode. The main physiological function considered for self-control in TTH is, of course, muscle tension (face, neck and shoulders).

Cognitive-behavioral therapy

Cognitive-behavioral therapy is a multimodal intervention [42] that typically comprises various modules of treatment: RT; improvement of self-monitoring regarding headache and possible triggers (by keeping a diary); restructuring of dysfunctional cognitions and attitudes (e.g., decreasing catastrophizing, ruminations and depressive thoughts); improvement of coping with pain, in particular strengthening of self-efficacy beliefs; diverting attention from pain; and the enhancement of self-assertiveness and self-confidence. In addition, a training module to identify and solve problems (stress management) is included in most programs. Furthermore, the maintenance of activities in spite of pain (except in episodes of migraine) is advanced, especially if avoidance is a central feature of pain behavior. Some treatment programs also involve the parents, who are educated to improve coping with their children's pain [43] and to not reinforce pain behavior. Whereas biofeedback is a treatment format targeted at a single patient, RT and CBT are often administered in a group setting [42].

State of evidence regarding psychological treatments

As several meta-analyses on psychological treatment of pediatric headache exist, this article will concentrate on them and refrain from a detailed analysis of single original studies. In 2002, Hermann and Blanchard presented an overview of studies evaluating biofeedback [44]. They included eight studies on the treatment of migraine with different designs (randomized controlled trials [RCTs], multiple baseline and clinical trials), where thermal biofeedback aided by home relaxation exercises was evaluated. A further seven studies were presented in which biofeedback (thermal, vasomotor activity, contingent negative variation [EEG parameter: contingent negative variation], electromyograph) was combined with another treatment, for example, CBT or RT. In some studies, feedback training was based on more than one physiological function. The authors determined the intraindividual change (pre-post differences) and found symptom reductions with effect sizes of between 0.32 (small) and 5.71 (extraordinarily large). Of 16 effect sizes for biofeedback or combined interventions, ten were above 1.0.

The authors also turned their attention to the treatment of TTH and 'mixed' headache. They discovered five studies evaluating electromyograph biofeedback, in some cases this was combined with RT. Two of the treatment studies were RCTs. Three out of the eight effect sizes reported were above 1.

Hermann and Blanchard also examined long-term efficacy, which was assessed in 6–12-month follow-ups [44]. Improvement could be maintained in a considerable number of studies, the

effect sizes had even increased at follow-up. Since controls such as waiting list groups are not usually monitored until follow-up (subjects are treated after the post-therapy period), it cannot be decided whether the large effect sizes reflect a natural process regarding improvement over time or the efficacy of the treatment.

In summary of the findings, the authors [44] presented convincing empirical evidence (though not all studies were RCTs) that biofeedback, either alone or in combination with another intervention, produces distinct improvement in migraine, which even tends to increase over time.

The findings regarding the efficacy in nonmigrainous headache are more difficult to interpret. Hermann and Blanchard only found studies in which children's headache was either mixed or not clearly defined. Effect sizes seemed to be somewhat smaller than for the treatment of migraine. Unfortunately the review did not present a statistical synopsis of observed effects, nor was a stringent statistical comparison of the biofeedback treatment of migraine versus other headache performed.

In 2006, Trautmann *et al.* published a meta-analysis on psychological treatments of recurrent headache that was based only on RCTs, because the high internal validity of this type of study offers the strongest scientific evidence [45]. The meta-analysis included all treatment formats with a psychological basis. The authors found 43 studies in total, but had to reject 23 due to their failing to fulfill one or more of their inclusion criteria (e.g., no control group, no randomization or no data given to compute effect sizes). Most studies comprised sample sizes with $n = 30$ –50. Nine studies were found on the treatment of patients with migraine and only one with patients diagnosed as TTH. The largest number of studies conducted examined relaxation training (see TABLE 1).

Table 1. Study characteristics of meta-analysis on pediatric headache treatment by Trautmann *et al.*

Publication year/number of studies	1980–1995 >1995	12 (52%) 11 (48%)
Sample size	<30 >50	6 (26%) 3 (16%)
Mean drop-out rate	5–10% >20%	13 (65%) 2 (10%)
Treatment setting		
Group	4	17%
Individual	15	65%
Both	4	17%
Treatments evaluated		
Biofeedback	7	11%
Relaxation	16	27%
CBT	10	17%
Combination	6	10%
Recurrent headache treated		
Migraine	9	39%
TTH	1	4%
Diverse	13	57%

CBT: Cognitive-behavioral therapy; TTH: Tension-type headache.
Data taken from [45].

A rather conservative method of analysis was used (e.g., Hedges g for effect size computation, correction for small sample size and nonsignificant differences treated as $g = 0$). Between-group effect sizes and intra-group (pre-post/pre-follow-up) were computed and compared in regard to different variables, such as clinical significant change, frequency of headache episodes, duration, intensity and medication.

Intragroup effect size differed between the treatment and waiting list conditions, clearly favoring the treatment groups. The inter-group effect sizes – indicating efficacy of the active treatment – were low (<0.50) regarding headache variables (intensity, duration and frequency) and medication, but high (>0.80) regarding the number of responders (decrease of headache $\geq 50\%$). A responder rate of 70% was found in the treatment conditions and only 30% improved in the control groups. As reported before, also this meta-analysis indicated an improvement of outcome at follow-up (pre-post effect size: 0.55 / pre-follow-up effect size: 1.0). Differences between treatments of different headache types could not be analyzed due to the small number of studies.

This meta-analysis produced distinctly lower effect sizes than the earlier analysis of biofeedback treatment [44], however the reasons for this are difficult to identify, since only a few studies were included in both analyses. Due to the conservative and stringent method of analysis, the findings of Trautmann *et al.* are beyond suspicion of overestimating efficacy of treatments [45].

The most recent meta-analysis on pediatric pain [46] included 25 RCTs and is an update of the first review of Eccleston *et al.* from 2002 [47]. A total of 20 studies focused on headache treatment, and the rest dealt with other pain problems. The general conclusions of the authors were based on findings from all of the studies. The authors rated the methodological quality of the studies and found it to be of an 'average' quality, similar to adult treatment studies. The most impressive result revealed that treated children have a sixfold higher chance (odds ratio [OR] = 5.9) of clinical improvement ($\geq 50\%$ headache reduction) directly after therapy than the nontreated children, and that the OR at follow-up is even higher (OR = 9.88). The 'number needed-to-treat' (NNT = 2.64) signifies that less than three children have to be treated to achieve one 'success', which is a very good outcome. Palermo *et al.* only found six studies assessing disability and emotional functioning associated with headache [46]. The analysis revealed no significant effect of treatment on these outcome variables, which was quite unexpected. In our recent study we also did not achieve a reduction in depressive symptoms and headache-related disability [48]. We suspect the low baseline level of these variables to be responsible for this, a finding that also questions the often assumed psychopathology in headache sufferers [28].

Based on four studies it was documented that therapist-administered therapy and structured self-help training are equally effective.

Meanwhile, four RCTs on internet- or CD-based treatments working with CBT concepts were published [43,48–50]. The authors of the above meta-analysis [48] examined two of the studies and did not find differences in efficacy, compared with conventional treatment. Our group recently published a report on internet-based training [51], comparing a multimodal CBT to applied relaxation

and a waiting list control. Whereas the responder rate (n with $\geq 50\%$ improvement) was comparable to CBT administered in groups, and significantly higher than in the control group, average improvement in intensity, frequency and duration was low and not significantly different from the waiting list. No significant differences between the active treatments could be detected. The failure to statistically assure differences between conditions must be partly blamed on the high attrition rate after therapy and especially during the follow-up period (reducing the power of the study). Many of the participants did not return the diaries and questionnaires. However, the observation that only a few participants dropped out during the training was encouraging [48].

Conclusions

It can be safely concluded that psychological treatments have proved their efficacy on the top level of evidence [52], which means that methodological well-designed randomized control studies exist, supporting efficacy, and meta-analyses confirm these results on a hierarchially higher level. In particular, the number of children that can be classified as responders – because they have shown a drastic decrease in headache episodes – is high. This effect is also reflected in high ORs comparing the chance to improve after treatment to no treatment as being 6–10-times higher. The number of headache patients who have to be treated to find one ‘responder’ is consequently very low (<3).

The failure to find large intergroup effect sizes when looking at single headache parameters, such as intensity, duration or frequency, is, at least partly, a consequence of the very large interindividual variance in these variables. Medication often does not show significant changes, mainly because its use at baseline is generally rather low.

The children who participated in these treatments commonly report a high acceptance of the training and are very satisfied with it [46,51]. One ‘outcome’ that is rarely documented, but seems to be of a particular importance, is the response of parents to the treatment. As a consequence of therapy the children report taking over responsibility for the management of their headache, feel able to cope with it and need less support from their parents [51]. This often leads to a substantial relief in parents while reducing their helplessness felt in dealing with the child’s pain problem. Thus, parents are also commonly very satisfied with the treatment [51].

Expert commentary

Although the state of evidence regarding pediatric headache treatment in general is satisfying, there are shortcomings that leave researchers rather uneasy. Usually the samples are too small to evaluate differences between active treatments (if these are included at all). Thus, data are giving the impression that ‘everything’ works and efficacy is the result of unspecific processes that cannot be traced down. Consequently the mechanisms of action remain more or less hypothetical. This is one reason why attempts to systematically improve training formats based on empirically supported theoretical assumptions cannot be undertaken. Furthermore, we only have very few studies comparing the effect of drug treatment, especially preventive drugs, to psychological interventions, neither regarding efficacy, cost-effectiveness nor attrition rate. The vital

consequences of headache, namely disability, activity interference and reduced quality of life, have not been addressed thoroughly although this has been suggested by the PedIMPACT group [53]. In addition, we are still not able to judge the observed long-term headache improvement observed in follow-ups with regard to its internal validity.

Nevertheless, although the efficacy of psychological treatment is corroborated, it is regrettable that the chances of psychological therapy are too often overlooked or ignored, not only by pediatricians and neurologists, but also by parents. Psychological treatment is capable of initiating a belief in self-controlled healthcare in an early phase of life, which could have long-term positive effects on the individual. Although drug therapy of an acute severe migraine attack may not be dispensable in some cases, psychological treatment is suited to strengthen the ability and the belief that one is able to participate in the management of one’s own health and is not utterly dependent on pharmacology. However, there are large barriers regarding the availability of psychological treatment for children in need, based on the scarcity of professional therapists interested and skilled in psychological headache treatment.

The internet- or electronic media-delivered interventions offer the perspective that in the near future psychological treatment can be offered to more children and adolescents with headache, since access to training is made easier. Furthermore, the threshold to participate in a media-based therapy is probably lower than to consult a therapist on a regular basis, while there is some evidence that efficacy might catch up with conventional treatment.

Five-year view

Research studies with larger samples are needed, allowing a comparative design (i.e., the inclusion of more than one active treatment). Furthermore researchers should try to elucidate the mechanisms of action and mediators of change. Thus cognitive-emotional processing should be more thoroughly analyzed (modification of coping strategies, evaluation of cognitive appraisal, change of behavior and affective state, effect on disability and quality of life). In particular, the examination of changes in disability, activity interference and quality of life by psychological headache therapy is necessary and has to be compared with conventional pharmacological treatment. In addition, potential physiological mechanisms involved in headache reduction need to be analyzed (e.g., parameters of physiological arousal, peripheral and central mechanisms of pain inhibition). The electronically mediated programs deserve a more in-depth examination and their potential should be systematically scrutinized. In addition, research should take a long-term prospective view and examine the course of headache for several years after the headache treatment has ended.

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Key issues

- Recurrent headache is the most common pain syndrome in children and adolescents.
- Considerable disability due to headache is present in approximately 4% of the afflicted children and this indicates a need for treatment.
- Medication for the acute attack, which is especially painful in migraine, is now available for children but is often considered with reluctance.
- Drugs for the prevention of headache attacks are rare and only applicable in migraine.
- The main directive of psychological treatment is the prevention of future headache attacks and the modification of cognitive and behavioral mechanisms aggravating pain and leading to severe disability and interference with activities of daily life.
- The main treatment modalities that have been empirically evaluated are relaxation training, biofeedback and cognitive-behavioral therapy.
- Efficacy – including long-term change – of all these treatments has been confirmed in randomized controlled trials and even by meta-analyses of controlled studies.
- Efficacy regarding clinically relevant change (reduction of headache at least by 50%) is high (~70%).
- Media based self-management programs could increase the availability of psychological treatment to more juvenile headache sufferers.
- Future studies have to focus on the exploration of mechanisms of change, and should include the assessment of therapeutic goals other than headache reduction (e.g., quality of life).

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