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Evaluation of an App-Supported Intensive Interdisciplinary Treatment for Young People with Chronic Pain: A Mixed-Methods Study

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Abstract: Chronic pain in the vulnerable phase of emerging adulthood is associated with severe life impairments. The current healthcare system has no suitable treatments for young people. A new multimodal inpatient and app-supported treatment for young people with chronic pain counteracts this. The study examines the effectiveness of this new treatment. Our mixed-methods design combined qualitative and quantitative evaluations. The sample comprised $N = 44$ patients (18–25 years) who took part in the new treatment. The quantitative data showed a reduced degree of pain severity, pain-related and emotional impairments, and an improved quality of life. The qualitative data showed that several components of the new treatment were particularly important to the young adults: individuality and taking the patient seriously, group therapy with peers, individual therapies (psychological, medical), life counselling, and sports. Results support the individual and objective success of a new inpatient pain treatment applied during emerging adulthood.

Keywords: chronic pain; emerging adulthood; youth; intensive interdisciplinary pain treatment; qualitative interview study; quantitative evaluation



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1. Introduction

Chronic pain is one of the most common health problems across age groups [1,2]. According to a current scoping review, 5% to 30% of young people between 18 and 29 years suffer from chronic pain, with more women being affected than men [3]. In this population, chronic pain is associated with impairments in social and professional life, restrictions in physical functioning, and impaired emotional well-being [1,4]. Therefore, chronic pain in this vulnerable phase of life is associated with negative long-term consequences for professional and personal development [5].

An effective therapy can potentially counteract these negative long-term consequences [6]. Multimodal interdisciplinary treatment is the therapy of choice for severely disabling chronic pain irrespective of age [6,7]. According to a recent study, young people have special needs regarding pain therapy that differ from older people and adolescents; this warrants a separate treatment concept for this age group [8]. However, to our knowledge, such an age-specific interdisciplinary inpatient treatment program has not been described in the literature. Only one previous study examined the effectiveness of an intensive interdisciplinary inpatient treatment program originally designed for adolescents and applied to young people with chronic pain. This study showed that pain-related and emotional impairment significantly decline after treatment. Furthermore, it offered first insights into the modulating effect of autonomy on positive treatment outcomes and therefore underlines the need to tailor treatment to the needs of young people [9].

In the outpatient setting, however, there is a recently published study that supports the assumption that interdisciplinary pain rehabilitation programs for pediatric and adult populations are not designed specifically to address the developmental needs of young people [10]. Morrison et al. [10] developed a novel intensive interdisciplinary outpatient rehabilitation program tailored to the unique needs of young people with chronic pain. Their outcome data demonstrated treatment gains with reductions in pain interference, pain severity, pain catastrophizing and depressive symptoms, and improvements in mental and physical quality of life, perceived performance, perceived satisfaction with performance, and objective measures of physical functioning. The findings of these previous studies suggest that an interdisciplinary treatment program tailored to the unique needs of young people with chronic pain could also be useful and promising in the inpatient setting.

To close the gap in healthcare provision, an interdisciplinary inpatient pain treatment concept for young people has been developed (see Section 2.4) based on the results of the aforementioned studies [8]. The newly developed inpatient pain treatment [11] takes the special needs of young people into consideration [12]. Regarding the digital affinity among young adults and to ensure stable and sustainable treatment success, an app for smartphones and tablets was made to support treatment and aftercare.

The aim of the present study was to evaluate the effectiveness of this new interdisciplinary pain treatment for young people with chronic pain by means of a mixed-methods approach. The quantitative part addresses effectiveness regarding pain severity, pain-related and emotional impairment, and quality of life in a pre-post-design. In the qualitative part of the study, the young adults were asked about their experiences with the treatment concept in order to understand what was helpful for them.

It is anticipated that the new interdisciplinary pain treatment for young people with chronic pain will lead to significant reductions in pain severity, pain-related and emotional impairment, and improvements in quality of life.

2. Materials and Methods

2.1. Study Design

Our mixed-methods design combined qualitative and quantitative research methods to comprehensively describe the effectiveness of the new app-supported treatment program. The presentation of the qualitative study is based on the COREQ checklist [13].

Data were collected using focus group interviews (face-to-face at the German Paediatric Pain Centre) and qualitative individual interviews (telephone). Focus groups were conducted at discharge and three months after discharge (3-month follow-up). Individual interviews were carried out at 3-month follow-up. Change in core outcomes after treatment was measured using a quantitative evaluation with standardized questionnaires at two time points (treatment admission and 3-month follow-up). Chronic Pain Grading (CPG; [14]) was defined as primary outcome; all the other parameter are secondary outcomes (mean pain intensity, pain-related impairment, disability days, emotional impairment, and quality of life).

2.2. Sample

The sample comprised young adult pain patients (18–25 years) who took part in the new intensive app-supported interdisciplinary pain treatment. To take part in this inpatient treatment program, patients had to be diagnosed with a somatoform pain disorder (ICD-10-GM F45.4 [15]) or a chronic pain disorder (ICD-10-GM F45.41 [15]), and they had to fulfil at least three of the following five criteria (which are defined in German OPS 8–918 for diagnosis [16]): serious or foreseeable impairment, at least one unsuccessful unimodal therapy attempt, misuse of or dependence on medication, mental co-morbidity, and serious somatic co-morbidity. Exclusion criteria for treatment were absence of organic diagnostics, serious mental co-morbidity more prominent than the pain disorder, acute suicidality, acute self-injurious behavior, and a lack of treatment motivation [17].

All patients who took part in the new app-supported treatment program for young people at the German Paediatric Pain Centre between February 2019 and September 2020 ($N = 58$) were eligible for study participation. All patients participating in the quantitative part of the study ($N = 44$) were also invited to participate in the qualitative part of the study.

A flowchart of the quantitative and qualitative aspects of the study is presented in Figure 1. At the 3-month follow-up, the participation rate was 77.3%.

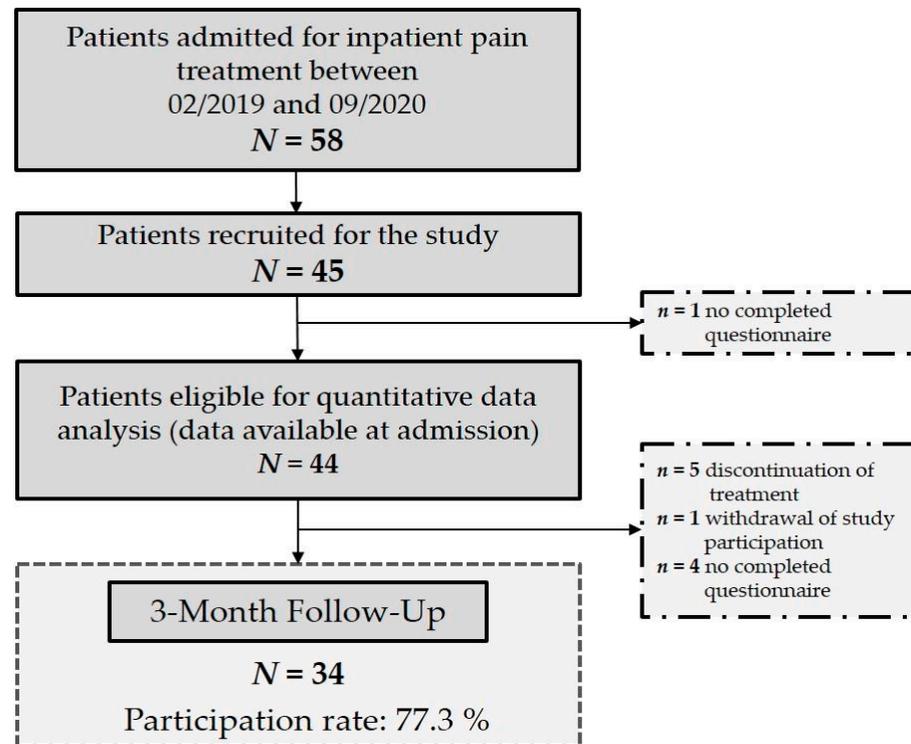


Figure 1. Flowchart.

A dropout analysis was performed to detect significant differences (between the included and the dropout sample; see Section 3.1).

The qualitative part of the study included six face-to-face focus groups with 3–8 patients (discharge and 3-month follow-up) and 15 individual telephone interviews (discharge and 3-month follow-up). Participants were free to take part in the focus group and/or the individual telephone interview. Altogether, there were statements from 34 patients at 3-month follow-up (see Figure 1). All participants in the quantitative study also took part in the qualitative study.

2.3. Procedure and Measures

Written informed consent to participate in the study was obtained from all participants. Individual interviews were conducted by a single interviewer (medical student) by telephone and lasted between 15–30 min. The focus groups were carried out by a psychologist (S.S.) and a pediatrician (D.G.) and lasted approximately 60 min. All interviews (individual, group) were audio-recorded and transcribed word for word (pseudonymized). The evaluation of the already available data took place at the same time as the further data collection. Paper–pencil questionnaires for the quantitative study were completed at admission and online at 3-month follow-up using unique anonymized study identification numbers.

2.3.1. Interview Guideline

The qualitative interviews included narrative-stimulating questions that allowed participants to articulate their personal views. At the same time, the underlying thematic guidelines provided the opportunity for interviewers to respond flexibly over the course

of the interview by asking further and complementary questions. The guiding questions were developed by the research team. The guiding questions used in the focus groups and individual interviews were as follows:

- Was the inpatient treatment suitable for you? To what extent were your needs for inpatient treatment met, both in terms of content and structure? What were your experiences?
- Which therapy components helped you particularly well? Which were less helpful?
- Do you think the program is effective?

Additional questions at the 3-month follow-up:

To what extent has your pain situation changed in the three months after treatment?

How is your quality of life after treatment? Are there still impairments in your everyday life and if so, which ones?

2.3.2. Demographic Variables and Pain Characteristics

Demographic variables such as age, gender and living situation as well as the pain characteristics “main pain location” and “onset of pain” (six levels from ‘less than 1 month’ to ‘more than 5 years’) were collected via the German Pain Questionnaire [18,19].

2.3.3. Pain-Related Disability and Degree of Pain Severity

Further pain-related parameters were also recorded with the aid of the German Pain Questionnaire. These include current, average, and maximum pain intensity in the past four weeks (eleven-point numerical rating scales, 0 = no pain to 10 = strongest pain). Pain-related disability was measured as the mean pain-related impairment applicable to everyday life, leisure time, and ability to work (eleven-point numerical rating scales, 0 = no disability to 10 = strongest disability) as well as the number of ‘disability days’ (days absent from work in the past three months) [18–20]. The Chronic Pain Grading (CPG; [14]) as a measure of pain severity was calculated on the basis of the patient’s rating of pain intensity (mean of current, average, and maximum pain intensity multiplied by 10), the pain-related disability score (mean of interference in everyday life, leisure time, and ability to work multiplied by 10), and disability days. Based on these measures, patients were assigned to five different grades of chronic pain severity (0 = no chronic pain; 1 = low pain intensity/low disability; 2 = high pain intensity/low disability; 3 = high disability, moderately limiting; and 4 = high disability, severely limiting). The CPG was defined as the primary outcome of our quantitative study part.

2.3.4. Emotional Impairment

Emotional impairment was recorded using the German Pain Questionnaire’s Depression, Anxiety, and Stress Scale (DASS) [19]. This tool consists of 21 items, with 7 items each being used to record depression, anxiety and individual stress levels. The response scale ranged from 0 (“did not apply to me at all”) to 3 (“applied to me very often or most of the time”). All items are polarized in the same direction, so the scale sums are calculated by simple addition. For the depression and stress subscales, a value above ten indicates a significantly high emotional burden. For the anxiety scale, a total of six is assumed to be the critical cut-off value. This scale has good internal consistency (depression: Cronbach’s $\alpha = 0.88$, anxiety: Cronbach’s $\alpha = 0.80$, stress: Cronbach’s $\alpha = 0.87$) [21].

2.3.5. Quality of Life

Subjective well-being as a central dimension of quality of life was recorded via the Marburg questionnaire on habitual well-being (MFHW; [22]). This questionnaire measures the subjective feeling of satisfaction with one’s own existence. It consists of 7 items with responses reported on a 6-point Likert scale (0 = extremely dissatisfied to 5 = extremely satisfied and a total score of 0 to 35), with higher values indicating a greater feeling of satisfaction. A total <10 is considered the cut-off value for poor well-being [18,19]. This scale has good internal consistency in pain patient samples (Cronbach’s $\alpha = 0.87 - 0.92$ [23]).

2.4. App-Supported Interdisciplinary Inpatient Treatment for Young People

The three-week inpatient treatment program was carried out in a group setting of 6–8 young people. Details on the program are provided in a therapy manual [11]. The young people were treated using an interdisciplinary multimodal approach by physicians, psychologists, nurses, physiotherapists, and additional professions such as music and art therapists. The treatment program was based on a biopsychosocial understanding of chronic pain, prioritizing active pain management and pain education. The patients' individual pain problems were examined in psychotherapeutic individual and group sessions against the background of their individual life and illness history. Taking the patient seriously is the basis of the therapy and essential as a therapeutic attitude.

Group therapy consists of both neuroscience education in groups (acute versus chronic pain, pain processing in the brain, biopsychosocial model of pain, etc.) and joining everyday life activities in the group. Other group therapies include art therapy, music therapy, and relaxation.

Psychological one-on-one therapy may incorporate biography work, positive reflection, social competence training, emotion regulation, pain management strategies and the development of motivation for outpatient psychotherapy. It also encourages taking a prospective perspective, through activities such as individual life planning. In single sessions with the physician, patients can bring forward their questions regarding prior clinical findings and their health condition, and where needed receive concrete instructions on the correct use of analgesics. Individual therapies also include biofeedback and physiotherapy according to individual needs. Both individual and group therapies also prioritize active movement during treatment (e.g., physiotherapy and sports).

An app for smartphones and tablets was developed to complement these inpatient treatments and aftercare. It contains extensive educational materials, such as treatment-related pain management strategies. The educational modules include information on acute versus chronic pain, pain processing in the brain, the biopsychosocial model of pain, explanations on different types and localizations of pain, as well as on different therapy options (e.g., for migraine, information on analgesics), and description of the relationship between pain and psychological comorbidities. The pain management strategies contain relaxation audio files and instructions (e.g., progressive muscle relaxation, dream journeys), digitally supported mindfulness exercises, distraction exercises, incentives and reminders for physical exercise and positive activities, and cognitive strategies (positive diary and resource activation). The app uses gamification elements for motivation. Patients could access the app at any time during their treatment program.

2.5. Data Analysis

For the quantitative study, the arithmetic mean (M), standard deviation (SD), median (Mdn) or frequencies are reported as descriptive distribution parameters. A significance level of $\alpha = 0.05$ was set for inferential statistical methods. To avoid familywise error, data were Bonferroni–Holm-corrected according to the number of tests per research question, and the local significance level was recalculated after each test [24]. Changes in the ordinal Chronic Pain Grading were analyzed using a Wilcoxon signed rank test between pre-treatment and 3-month follow-up. Due to non-normality, non-parametric Wilcoxon signed rank tests assessed emotional impairment, quality of life, and other pain parameters. Effect sizes[®] were calculated by dividing the z-values of the Wilcoxon signed rank tests by the square root of the sample size n: $r = |z|/\sqrt{n}$ [25]. This made it possible to standardize treatment effects regardless of an individual scale's unit of measurement [26]. According to Bühner and Ziegler [27], $r = 0.10$ corresponds to a weak effect, $r = 0.30$ to a medium effect, and $r = 0.50$ to a strong effect.

Evaluation of the qualitative interviews was carried out using qualitative content analysis [28] and MAXQDA software (Version 2018). The analysis process was guided by a systematic coding procedure in order to structure the interview data into main and sub-categories with regard to the research questions. The themes of the interview guide

served as deductive main categories for the three experts from the research team (psychologist (S.S.), pediatrician (D.G.), nursing scientist (A.H.P.)) and guided the analysis process (e.g., peer group, psychotherapy, individuality). The corresponding subcategories were then formed inductively from the interview data. Identified themes that could not be assigned to the main categories were included as additional categories (e.g., life counselling). The categories were discussed in the analysis group in five meetings and determined by consensus. In this paper, citations are used for illustrative purposes.

2.6. Ethics

This prospective longitudinal cohort study was approved in accordance with national law and the Declaration of Helsinki [29] by the ethics committee of the University of Witten/Herdecke (135/2018). All study participants provided informed consent.

3. Results

3.1. Patient Population and Dropout Analyses

The demographic variables and pain characteristics of participants eligible for analysis (N = 44) are reported in Table 1.

Table 1. Characteristics of the study sample at inclusion.

	N	%	M	SD
Female sex (N = 44)	33	75.0		
Age (N = 44)			19.3	1.5
Living situation * (N = 43)				
Alone	6	14.0		
With partner	2	4.7		
With children	2	4.7		
With parents	32	74.4		
Flat share	6	14.0		
Onset of pain (n = 43)				
1 month to ½ year	1	2.3		
½ year to 1 year	2	4.7		
1 to 2 years	5	11.6		
2 to 5 years	14	32.6		
More than 5 years	21	48.8		
Pain location * (N = 43)				
Head	21	48.8		
Abdomen	8	18.6		
Musculoskeletal	24	55.8		
Whole-body pain	7	16.3		
Pain intensity in the past 4 weeks (n = 43)				
Average			6.1	1.9
Maximum			8.4	2.0
Functional impairment (n = 43)				
Pain-related impairment			5.9	1.9
Disability days after 3 months			36	32.3
Chronic pain grading (n = 43)				
CPG 1	3	7.0		
CPG 2	2	4.7		
CPG 3	16	37.2		
CPG 4	22	51.2		

* Multiple answers possible.

Dropout analyses examined patients who took part in the 3-month follow-up (n = 34) and those who did not (n = 10). Dropouts had a slightly higher number of disability days (p = 0.020) and a higher CPG (Chronic Pain Grading; p = 0.033). Those differences were not significant after Bonferroni–Holm correction. There was no difference in age, sex, onset of pain, pain location, pain intensity, or pain-related impairment.

3.2. Quantitative Results: Treatment Success

The quantitative results focus on the treatment success of the new program after 3 months compared to the time before admission.

3.2.1. Pain-Related Disability and Degree of Pain Severity

Analyses yielded a significant decrease in CPG, which was the primary outcome of this study (Wilcoxon test, $n = 33$, $z = -4.004$, $p < 0.001$, Bonferroni–Holm-corrected) with a strong effect size ($r = 0.70$). Before treatment, 84.8% of the analyzed patients were classified as CPG 3 (42.4%) or CPG 4 (42.4%). At the 3-month follow-up, only 35.3% of patients were considered CPG of 3 or 4 (CPG 3: 20.6%, CPG 4: 14.7%) (see Figure 2). The other pain outcome parameters showed that pain intensity, pain-related impairment, and disability days decreased significantly three months after treatment (see Table 2).

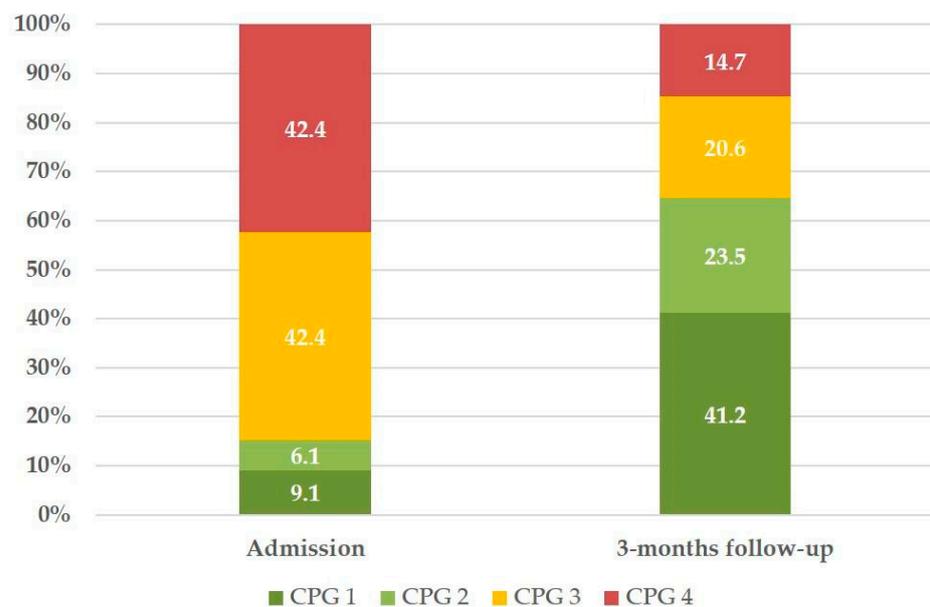


Figure 2. Pain severity.

Table 2. Quantitative treatment outcomes.

	Treatment Admission Mdn	Admission IQR	3-Month Follow-Up Mdn	3-Month Follow-Up IQR	z	p	r
Pain characteristics ($n = 33$)							
Mean pain intensity	7.00	3.33	5.00	3.67	-2.93	0.003	0.51
Pain-related impairment	6.33	3.00	3.17	4.08	-4.28	<0.001	0.75
Number of disability days	25.00	52.00	2.00	11.25	-3.61	<0.001	0.63
Emotional impairment ($n = 33$)							
Depression	6.00	9.00	3.00	6.00	-2.94	0.003	0.51
Anxiety	4.00	4.00	2.00	6.00	-1.72	0.086	0.30
Stress	9.00	8.00	5.50	7.00	-2.77	0.006	0.48
Quality of life ($n = 33$)	16.00	13.00	22.00	16.00	3.23	<0.001	0.56

All p values are significant after Bonferroni–Holm correction.

3.2.2. Emotional Impairment

There was a moderate to large significant reduction in depression and stress (see Table 2). Before treatment, 24.2% of patients were above the critical cut-off value for depression and almost half of all patients showed critical stress levels (42.4%). At the 3-month follow-up, only 8.8% of patients showed noticeable depression values and the number of patients with increased stress scores was halved (20.6%). Anxiety did not decrease significantly (see Table 2).

3.2.3. Quality of Life

Comparing pre-treatment versus three months follow up demonstrated a significant improvement in quality of life (see Table 2). At admission, 21.2% of patients showed a reduction in their quality of life. The number of patients with impaired quality of life was significantly lower after the treatment; only 14.7% of the patients reported impaired quality of life at the 3-month follow-up.

3.3. Qualitative Results

The qualitative results focus on the effectiveness of the new treatment from the perspective of the young adults.

3.3.1. Relevant Aspects of the New App-Supported Treatment

The qualitative analyses first aimed to identify which aspects of the newly developed, app-based treatment concept were particularly effective. Several categories were identified in the interviews (Figure 3):

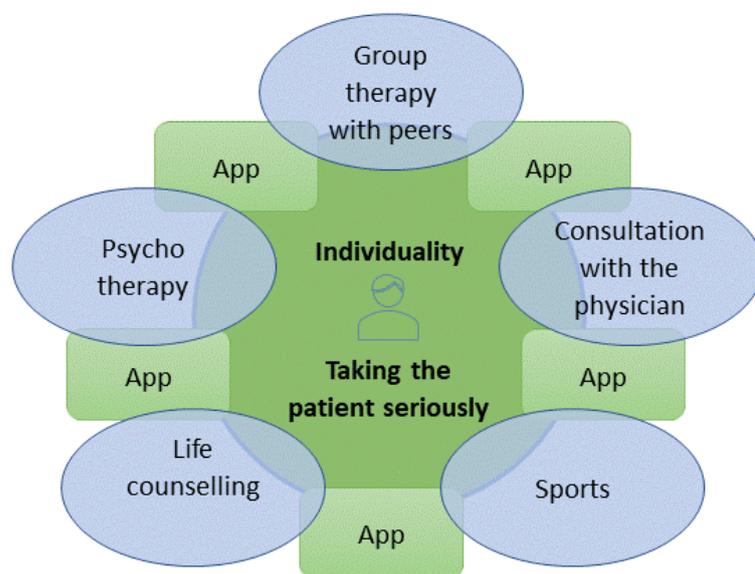


Figure 3. Qualitative evaluation categories.

Individuality and Taking the Patient Seriously

Being recognised and heard as a person or individual was particularly important to the interviewees. These aspects recur in the interviews, both directly and in-directly, and are considered particularly important and helpful in individual and group therapy.

In this context, the interviewees also mentioned that a regular structure and daily planning was very helpful, but combined with the possibility to choose from different offers. Some forms of therapy were perceived by individual young adults as very suitable for themselves, while others clearly rejected them for various reasons. This was apparent, for example, in the case of music and art therapy programmes.

One-on-One Therapies and Group Setting with Peers

The offer of individual psychological therapy and individual medical consultations was emphasized as particularly positive both in the focus groups and in the individual interviews. *“In any case, the one-to-one sessions with the psychotherapist are good for me, you can say anything that’s on your mind.”* In their individual consultations with the physician, patients particularly appreciated aspects such as detailed evaluation of diagnostic findings, making a diagnosis, and clarifying the necessity of drug therapy and, if necessary, the arrangement of optimally dosed pain medication. These consultations contributed to young

people feeling they were taken seriously. “. . . I found it very helpful because I was finally given the right diagnosis. What was very good, above all, was that I got a bit rid of the medication” one young adult said.

Group therapy was repeatedly experienced as helpful when, for example, the understanding of pain was discussed at a level appropriate to the age group. Some things were already known and did not help as much, but other educational content was important for consolidating knowledge and basic understanding. The variety and diversity of the offers as well as the option to “look into many things” and try them out were emphasized as positive, especially in order for the patients to develop their own strategies (for example to develop their own plan for less school stress). Even if “not everything could be solved completely, it was good.” One young adult said: “Well, you have to go for it and, yes, you have to try it out first to see if it’s for you and, yes, you really have to listen to your body”. The young people also repeatedly reported that they were taken seriously with regard to their pain experiences and were able to talk about themselves and their experiences whether within the peer group or with the therapists. One young adult explained directly after completing his treatment: “. . . If you have problems (. . .) you just talk. . . you’re just listened to and a solution is found. . . You are simply listened to and taken seriously.”

Life Counselling and Sports

Being able to constantly exchange ideas during therapy, both within the peer group and above all with the various therapists, was experienced as very valuable. An important related aspect of treatment is life counselling. Being provided support for the challenges of everyday life and decision making is incredibly valuable. As one participant described it, “I believe that the life counselling aspect is higher or should be of higher importance. . . than in the other groups.” They went on to explain that young people face a unique situation: “Someone between the ages of 18 and 25 who is either in training, studying or has been working for a while is perhaps totally unhappy, but doesn’t know what to do because he doesn’t know how everything works.”

Furthermore, young adult patients mentioned the value of sports as part of the treatment: “. . . sports are good for me, because I have noticed that I can still do it if I want to and I do not let myself be influenced by the illness.” Both the retention of their own tried-and-tested sports programs, such as running, and the choice of different sports options were emphasized.

“It was always great because I also realized, but even before that, that I get migraines much less often through endurance sports, i.e., regular running, and that I could continue with it.”

App Accompanying the Therapy

The use of the app varied greatly. Some frequently referred back to the knowledge section and passed this information on to those around them. The app provided supplemental “knowledge” and “strategies” to pertinent inpatient treatment modules and beyond. According to many interview partners, one young adult said “the knowledge part (in the app) is very good. I worked through it during my stay and showed it to my family.” Beyond that, relaxation techniques and the diary for writing down positive experiences were among the most popular: “What I particularly use is the Positive Diary, where I write down every day what I did and what went well during the day, what went badly, and what could go better.” Some rarely used the app, used it temporarily, or did not use it at all. They stated that they were not the mobile phone type, no longer needed the content because they are well, did not have time, or could not use the app at work. The app, which was introduced to participants during treatment, was thought to be useful for aftercare when patients move on to managing their daily lives: “I think the idea is good, because I think it is practically our daily routine we had in treatment but now for at home in another form.” “It’s like a little coach”, one young adult said.

3.3.2. Treatment Success

The second focus of the qualitative results was on the success of treatment from the young adults’ perspective three months after discharge.

The interviews conducted three months after discharge showed that most patients reduced pain, improving pain management and coping skills. *“It has become much better since the treatment. The pain does not even occur every day and if it does, I can handle it much better. So, the basic understanding of chronic pain has become very clear to me, and because I no longer pay attention to the pain, it has gone away.”* This success was not so clear for everyone. Some stated that the chronic pain was easy to integrate into everyday life using appropriate coping strategies, but that the pain peaks could hardly be influenced. In some cases, the problems of going to work were also greater than expected. Some stated that they had doubts about being able to take up and follow training or study. However, they were often able to develop a more positive outlook on life and their ability to work. *“Yes, I have become more confident in my career aspirations. I want to become a physiotherapist, I used to have doubts whether it would work with my pain. But now I no longer have those doubts.”* Patients talked about good approaches to solutions, “food for thought”, about feeling (mentally) better (more or less), about being able to help themselves, and about having more control. One person said that the therapy did not help at all but was also unable to make any suggestions for improvement. The overall results (3-month follow-up) show that the participants were mostly successful in finding ways that worked for them that helped them to improve their life situation and to cope with it in the long term.

4. Discussion

The present study provides the first evidence for the effectiveness of app-supported intensive interdisciplinary inpatient treatment for young people with chronic pain, especially regarding pain, emotional outcomes, and quality of life. The outcome data demonstrated that an interdisciplinary inpatient treatment program that addresses the special needs of young people with chronic pain leads to great treatment progress, similar to the outpatient setting (see [10]). It seems that treatment programs tailored to the unique needs of young people with chronic pain are efficient, full of benefits, and applicable across multiple treatment settings. Therefore, they are clinically recommended and should be implemented in the actual healthcare provision.

In the qualitative evaluation of the interviews, patients commended several characteristics of their treatment. They highlighted the importance of individuality and being taken seriously, engaging in medical consultation with a physician, group therapy with peers, psychotherapy, life counselling, and sports. Most of them appreciated the app’s treatment modules and viewed the app as an important addition to daily life, especially after discharge.

It is important to understand the challenges young people face in effectively managing chronic pain in this age group. Emerging adulthood is a phase full of possibilities, trying new things, and finding one’s identity [30,31]. Therefore, individuality is a crucial part of development during this phase. Experiencing a chronic health condition during emerging adulthood greatly slows this personal development. Uncertainty becomes more prominent, detachment from parents is hindered, and feelings of insufficiency develop due to the lack of independence. Individual psychological therapy offers young people a safe space in which they can express their worries and hopes and process their experiences in a more private, individualized and protected setting. Treating young people with respect as independent individuals and taking them seriously helps patients regain self-confidence [31,32].

Patients also reported group therapy with peers as a valuable treatment module. According to a study by Twiddy, Hanna, and Haynes [30], peer support is important to this developmental phase for the self-esteem of young people. They want to “belong” to the peer group [8]. Chronic pain hinders access to the peer group and makes social connections difficult, creating feelings of isolation. Disconnection from peers in this phase of life is detrimental to the development of emotional regulation strategies [30], adding to emotional instability. The treatment group offered the opportunity to connect with peers and develop social skills for future contacts outside the treatment setting. Young people obviously benefited from autonomy during treatment. They appreciated the opportunity to try out

different therapies and learn different pain management techniques. This allowed them to actively participate in their own treatment and independently assess which strategies were most effective for them.

The five treatment modules that patients considered most important were medical consultation with the physician, group therapy, psychotherapy, life counselling, and sports. These five modules address biological, psychological and social treatment goals. Our findings indicate that patients are very open to a biopsychosocial treatment approach. In the general population, youth concepts of pain cover biological as well as psychosocial aspects of pain [33]. In the course of treatment, this understanding of pain becomes increasingly well-founded. To summarize, the qualitative data conclude that young adults prefer a targeted group-specific and needs-based care structure (see Schenk, Genent, Hartenstein-Pinter, Zernikow and Wager [11]), linked with the possibility to choose from different offers.

The analyses of the quantitative data underline the effectiveness of app-supported interdisciplinary inpatient treatment for young people with chronic pain. Addressing the special needs and issues of young people seems to lead to good treatment success. Three months after the inpatient pain treatment, we observed a reduction in the degree of pain severity and pain-related impairment measures. In addition, the treatment effectively decreased emotional impairment and improved quality of life. Therapeutic approaches may reduce emotional impairments that are fed by the instability and uncertainty of emerging adulthood [31,32]. App support may be particularly beneficial in the three months after the multimodal inpatient treatment.

Chronic pain can lead to reduced social contacts and level of activity [34]. Especially during emerging adulthood, good and steady peer relationships are important for a positive emotional state [30,35], good quality of life [36], and psychosocial well-being [35]. Participation in our group treatment with other young people with chronic pain increased contact with peers who face the same challenges. Beyond that, group interactions aid identity development and mutual social support.

The strength of this study is its mixed-methods design, including qualitative and quantitative approaches. The qualitative aspect provides insights into the social reality of young people. *“The main interest here is to reconstruct the subjective self-perception and world view in a research process conceived as a dialogue”* [37]. This approach is characterized by both openness and a methodically guided procedure. Qualitative data collection aims to approach the *“object of research”* [38]. The quantitative evaluation is based on a longitudinal study design and complements findings through statistical analyses.

The results of this study must be interpreted considering some limitations. First, this study has no control group. In future trials, the effectiveness of treatment could be investigated in an RCT comparing a treatment group with a control group that is waiting for treatment, for example. Overall, the sample size for analyses ($N = 34$) is rather low. One reason is that the treatment groups were only offered at certain times of the year and not continuously. Recruitment possibilities were also limited as the size of the treatment groups were kept small; this contributes to therapeutic success. Due to the small sample size, we could not investigate any predictors of clinical characteristics that affect the outcome of intensive interdisciplinary treatment. It would be interesting to investigate these predictors in follow-up studies. This new treatment was evaluated for the first time. Both the sample size and the design followed a more exploratory approach. We would like to highlight that in the survey and evaluation of the interviews, the focus was primarily on positively experienced components. Only a few statements in the interviews addressed treatment components that were not helpful. It is possible that this answer pattern is caused by social desirability. In this study, the app was evaluated qualitatively, not quantitatively. Due to our study design, the effectiveness of specific therapy modules could not be investigated quantitatively. It is desirable to investigate the effectiveness of the app and individual treatment modules in follow-up studies. Another limitation of the present study is its unequal gender distribution. An analysis of potential gender effects was not possible due to small sample size. Last, a follow-up period of 3 months is rather short. Therefore, a

future study should investigate the effectiveness of the app-based treatment program over a longer time period.

It would be exciting to see future studies assess the economic impact of this app-based treatment program. Young people represent the future generation of a society that is undergoing demographic change. Since this phase of life lays the foundations for productive work through education and studies, effective pain therapy is particularly important to individual growth, not least for society.

The interviews showed that some aspects of the new app-supported interdisciplinary inpatient pain treatment can have a positive effect on coping with chronic pain, on the emotional experience, and on the quality of life of young people. Group therapy with patients of the same age, psychotherapy, physician consultation, life counselling, and sports are beneficial modes of treatment and might need more attention in the treatment of young people with chronic pain. Future studies should explore the mechanisms of treatment effectiveness in this patient population.

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