



Feasibility study of the psychosocial effects of an online mindfulness intervention in children and adolescents with achondroplasia and their parents

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ARTICLE INFO

Handling Editor: A. Verloes

Keywords:

Achondroplasia
Mindfulness
Family-based intervention
Children
Adolescents
Parents
Psychosocial well-being
Online intervention

ABSTRACT

Introduction: Achondroplasia is a common skeletal dysplasia caused by a mutation in the FGFR3 gene, leading to disproportionate short stature and various clinical features. Despite the absence of definitive pharmacological treatments, mindfulness-based interventions may offer psychosocial benefits for affected individuals and their families.

Objectives: This study aimed to assess the feasibility and psychosocial effects of an online mindfulness intervention for children and adolescents with achondroplasia and their parents.

Methodology: The intervention was an eight-week, synchronous online program with 15 participants: seven children and adolescents with achondroplasia and eight parents. Quantitative outcomes were assessed pre- and post-intervention using the State-Trait Anxiety Inventory for Children (STAIC) and the Multifactorial Self-Assessment Child Adaptation Test (TAMAI) for the younger participants, along with the Brief Symptom Inventory (BSI-18) for parents. Participant satisfaction was assessed using a customized survey, and qualitative data were collected through semi-structured interviews.

Results: The study demonstrated high feasibility, with 84.61% adherence and 93.75% participant satisfaction. Average anxiety levels decreased in children and adolescents (30.60 ± 5.12 to 26.80 ± 6.94 , $p = .285$) and parents (3.67 ± 3.98 to $1.00 \pm .89$, $p = .066$). Emotional regulation was the most reported improvement category by children and adolescents (31.4%), while general well-being was the most noted by parents (29.63%). **Conclusions:** The results support the feasibility of this online mindfulness intervention for individuals with achondroplasia and their parents, indicating benefits for psychosocial well-being. Future studies should address these limitations by expanding sample sizes, exploring hybrid intervention models, and ensuring data anonymity. Integrating mindfulness into comprehensive psychosocial care strategies could enhance the quality of life for these populations.

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<https://doi.org/10.1016/j.ejmg.2024.104984>

Received 20 August 2024; Received in revised form 4 November 2024; Accepted 23 November 2024

Available online 25 November 2024

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1. Introduction

Achondroplasia (ACH) is the most common form of skeletal dysplasia and the primary cause of disproportionate short stature, resulting from a mutation in the fibroblast growth factor receptor 3 (FGFR3) gene. Notably, most individuals with ACH are born to parents without this condition (Savarirayan et al., 2022b). The incidence of ACH is approximately one in every 25,000 live births (Coi et al., 2019; Foreman et al., 2020; Pauli, 2019). Diagnosis typically occurs prenatally in 66.6% of cases or immediately postpartum in 12.8% (Cormier-Daire et al., 2021).

The hallmark clinical features of ACH include disproportionate short stature, particularly affecting the limbs, facial hypoplasia, macrocephaly, lumbar hyperlordosis, hypotonia, bowed tibia, short fingers, and trident-shaped hands (Fredwall et al., 2020; Hoover-Fong et al., 2021; Merker et al., 2018; Pauli, 2019). Additionally, individuals with ACH may experience delays in motor skills, development, or language (Ceroni et al., 2018; Hoover-Fong et al., 2021), as well as difficulties in navigating architectural barriers and limitations in personal autonomy and hygiene (Ajimi et al., 2022; Unger et al., 2017). Medical complications associated with ACH include foramen magnum stenosis, spinal stenosis, sleep apnea, otitis, pain, dysphagia, obesity, and elevated mortality risk within the first four years of life, despite recent improvements in medical care (Bedeschi et al., 2023; Onesimo et al., 2023; Dhiman et al., 2017; Fredwall et al., 2020; Galasso et al., 2019; Kitoh et al., 2022; Okenfuss et al., 2020; Pauli, 2019; Saint-Laurent et al., 2019; Zaffanello et al., 2017; Hashmi et al., 2018).

Currently, there is no definitive pharmacological treatment for ACH, although several drugs are under investigation (Savarirayan et al., 2022a,b; Wrobel et al., 2021), with Vosoritide being a notable example that has already received approval from several regulatory agencies (Savarirayan et al., 2020; Tofts et al., 2024). However, the long-term efficacy of these treatments in counteracting ACH's effects remains uncertain (Pauli, 2019). Alternatively, surgical interventions, such as leg lengthening, as well as arm lengthening, are available (Batubay et al., 2020; Ginebreda et al., 2019; Leiva-Gea et al., 2020), but they are controversial due to potential complications and prolonged recovery periods (Hosny, 2020; Paley, 2021). In Japan, hormone treatment is also used to promote growth, though further research is required to establish its efficacy (Saitou et al., 2024).

Living with ACH extends beyond physical challenges, profoundly impacting psychological and social dimensions, consistent with the biopsychosocial model (Engel, 1992). Despite extensive documentation of the clinical features and medical complications associated with ACH, the psychosocial domain has received less scholarly attention (Bedeschi et al., 2023; Constantinides et al., 2022). Studies have reported significant negative impacts of ACH on psychosocial well-being (PSWB), particularly during childhood and adolescence (Nishimura and Hanaki, 2014; Pfeiffer et al., 2020a, 2021b; Shediach et al., 2022; Witt et al., 2017, 2019). These impacts include feelings of frustration and anger due to physical limitations or appearance (Lorne et al., 2020; Nishimura and Hanaki, 2014; Pfeiffer et al., 2020a, 2021b; Shediach et al., 2022; Witt et al., 2017, 2019), as well as feelings of difference, worry, sadness, depression, or shame regarding their condition (Okenfuss et al., 2020; Pfeiffer et al., 2020a, 2021b; Witt et al., 2019). These emotional challenges are often accompanied by low self-esteem (Shediach et al., 2022) and a reduced quality of life (QoL) (Llerena et al., 2022; Maghnie et al., 2023; Witt et al., 2019). Furthermore, children and adolescents with ACH face social challenges, such as being treated as younger than their age, having difficulties participating in social activities, keeping up with peers, being at risk of bullying, needing to explain their condition, requiring adaptations, missing school time, and facing stigmatization (Lorne et al., 2020; Pfeiffer et al., 2020a, 2021b; Shediach et al., 2022; Witt et al., 2017).

Conversely, some studies have highlighted protective factors in the PSWB of children and adolescents with ACH, such as fewer behavioural problems and high emotional functioning. These individuals may

demonstrate comparable or superior stress coping strategies and show positive self-concept and self-efficacy, with some expressing happiness regarding their condition. Positive social outcomes, including strong friendships, popularity, and positive attention, have also been documented, along with the beneficial effects of associations for individuals with growth-related conditions (Nishimura and Hanaki, 2014; Pfeiffer et al., 2020a, 2021b; Shediach et al., 2022; Witt et al., 2017).

The psychosocial impact of ACH extends to parents and caregivers, particularly at the time of diagnosis, which can be a critical point for PSWB. Parenting children with ACH often involves heightened stress and feelings of being overwhelmed, which can strain marital relationships, limit family activities, and increase the caregiving burden due to the child's greater need for care (Hill et al., 2003; Pfeiffer et al., 2020b, 2021a; Shediach et al., 2022; Witt et al., 2017; Pimenta et al., 2023). Parents may perceive the severity of ACH as greater than their children do (Law, 1987; Lorne et al., 2020; Witt et al., 2019), although some studies suggest the opposite (González and Hernández, 2001; Hunter, 1998a). Concerns about the future, including the child's well-being, happiness, social relationships, independence, and medical complications, are prevalent (Hill et al., 2003; Pfeiffer et al., 2020b, 2021a; Shediach et al., 2022). Additionally, parents face challenges in balancing work and family life, which can have economic implications and limit social interactions, contributing to lower levels of mental health and QoL, with repercussions on the child's well-being (Cormier-Daire et al., 2021; Pfeiffer et al., 2020b, 2021a; Shediach et al., 2022; Witt et al., 2019).

Nevertheless, some parents report experiencing positive family bonding and emotions, such as pride, gratitude, happiness, and optimism, associated with having a child with ACH. They may gain a new perspective on life and experience positive emotional effects, along with the supportive impact of associations for individuals with growth-related conditions. The role of parents is crucial in fostering self-esteem in their children with ACH, as the psychological impact of ACH is influenced by personal, ethnic, and cultural factors, with family perceptions playing a significant role (Ajimi et al., 2022; Bedeschi et al., 2023; Cormier-Daire et al., 2021; Pfeiffer et al., 2020a, 2020b, 2021a; Shediach et al., 2022; Unger et al., 2017).

Given these psychosocial challenges, it is imperative that individuals with ACH, as well as their parents, receive adequate psychological support (Bedeschi et al., 2023; Cormier-Daire et al., 2021; Hill et al., 2003; Maghnie et al., 2023; Wigg et al., 2016). Mindfulness, a practice of Buddhist origin developed by Jon Kabat-Zinn in 1979, has been widely applied in clinical interventions in the fields of education, medicine, and psychology, demonstrating effectiveness in promoting mental health (Galante et al., 2023; Kabat-Zinn, 2013, 2019). Mindfulness can be particularly beneficial for children and adolescents, fostering acceptance, presence, and understanding, and serving as a vital tool for developing emotional and social skills such as self-awareness, empathy, compassion, social competence, and conflict resolution (Semple et al., 2019; Snel et al., 2013). For parents, mindfulness principles, including non-judgment and full attention to thoughts, emotions, and bodily sensations (Kabat-Zinn, 2003), can aid in coping with their child's disability (Osborn et al., 2021). Specifically, Mindfulness-Based Cognitive Therapy (MBCT) was initially developed to prevent relapse in individuals with depression but has since been extended to various conditions, including social phobia, generalized anxiety disorder, emotional regulation issues, tinnitus acceptance, pain tolerance in migraines, and chronic conditions (Best et al., 2024; Marks et al., 2020, 2023; Segal et al., 2017).

To date, no studies have examined the effects of mindfulness on individuals with ACH or their families. Scientific research on mindfulness programs for people with disabilities and their relatives is relatively recent (Hwang & Singh, 2016; cited by Singh, 2020). However, mindfulness programs have been applied to enhance personal autonomy, emotional well-being, and self-control, with the resources gained through mindfulness practice potentially supporting social inclusion

(Hwang et al., 2024; Shogren and Singh, 2022). Additionally, mindfulness programs have been implemented for parents of children with disabilities to promote their psychological well-being (Burgdorf et al., 2019; Lunsy et al., 2021; Myers et al., 2023; Oñate and Calvete, 2019; Osborn et al., 2021).

Considering the limited research on the application of mindfulness in the context of disability, particularly in ACH, and given the rarity of this condition, there is uncertainty regarding the acceptance of such interventions within this population. Moreover, an online intervention was implemented due to the geographic dispersion of individuals with ACH. This feasibility study aims to evaluate the program's design, implementation, effects, and satisfaction, to inform future clinical or research applications involving larger samples (Pfledderer et al., 2024). It is worth noting that online mindfulness interventions for individuals with disabilities and their families have been previously proposed (Flynn et al., 2020; Lo et al., 2024; Marks et al., 2023; Myers et al., 2023; Osborn et al., 2021; Shallcross et al., 2022), including asynchronous formats (Flynn et al., 2020).

The primary objective of this study is to assess the feasibility and effects of an online mindfulness intervention, based on MBCT, on the PSWB of children and adolescents with ACH and their parents. Secondary objectives include evaluating the potential effects of the program on anxiety, self-esteem, self-concept, and social, school, and family adaptation in children and adolescents with ACH, as well as on anxiety, depression, somatization, and emotional well-being in their parents.

2. Material and methods

2.1. Study design

This feasibility study employed a quasi-experimental design with a mixed-methods approach and convenience sampling. The study involved an eight-week, synchronous online mindfulness intervention based on MBCT conducted between October 2022 and April 2023, supported by the Association of Families and Individuals Affected by Growth-Related Conditions (AFAPAC). The primary objective was to assess the feasibility of the intervention and explore its potential benefits on the PSWB of children and adolescents with ACH and their parents. Ethical approval was obtained from the Research Ethics Committee of the University of Vic – Central University of Catalonia (UVic-UCC) (211/2022), ensuring compliance with ethical standards, including informed consent procedures and confidentiality measures.

2.2. Participants and recruitment

Inclusion criteria were: (1) individuals aged 8–17 years diagnosed with ACH, (2) their parents, (3) had the commitment to ensuring an appropriate environment and actively participating in the sessions, and (4) had participated in at least six of the eight MBCT-based mindfulness sessions. Exclusion criteria included: (1) relatives who were not parents or legal guardians, (2) individuals who did not understand spoken or written Catalan, (3) individuals who did not understand written Spanish, and (4) failure to attend at least six of the eight scheduled sessions.

Participants were recruited through AFAPAC, following methods similar to those used in recent studies involving young people with ACH and their parents (Ajimi et al., 2022; Bloemeke et al., 2019; Pfeiffer et al., 2020a, 2021b; Witt et al., 2017, 2019). Recruitment was managed by the Principal Investigator (PI), A.C., in collaboration with the AFAPAC president, using telephone, text messages, and email, starting in February 2022. In March, AFAPAC distributed an informational form about the mindfulness intervention, which included videos by John Kabat-Zinn and Mario Alonso Puig, provided by PI. This form was sent to AFAPAC members in September 2022, along with a query about their interest in enrolling in the mindfulness course, their prior knowledge of mindfulness, and their views on a €20 enrolment fee to encourage adherence. An explanatory video in Catalan, created by the PI, detailed

the course characteristics and was sent with the registration form and a time preference survey to AFAPAC members in late September. In early October, reminder messages were sent to members, offering them the option to enrol in the course or, if uninterested, to join a convenience control group receiving no treatment.

Regarding data processing, questionnaires, and interview data were pseudonymized during the study. Given the longitudinal nature of the study, participants completed pre-intervention and post-intervention questionnaires, a satisfaction survey at the end of the intervention, and a semi-structured interview four months after the course. Data were coded and pseudonymized until the process was complete, after which the file linking identified data with assigned codes was deleted, ensuring full anonymity. Personal data were securely stored in the UVic-UCC OneDrive account folders, accessible only to the PI. Participants were informed of their rights to access, rectification, cancellation, restriction, portability, and opposition, and were provided with the PI's contact information to exercise these rights.

2.3. Intervention

The intervention sessions were held online via Zoom, using the institutional account of UVic-UCC, every Friday at 19:30. Participants required a computer device with a stable internet connection of at least 1.5 Mbps upload and download speed. It was emphasized that participants should avoid interruptions such as phone calls or other daily activities during the sessions and create an appropriate environment.

The mindfulness intervention was designed based on the MBCT manual (Segal et al., 2017) and adapted for children and adolescents using the framework provided by Semple et al. (2019). The program ran from October 2022 to December 2022, with one session per week. Due to participant absences, the sixth session was rescheduled for the following week. While the original MBCT program suggests a session duration of 2 h, this intervention shortened sessions to 60 min, consistent with other online MBCT studies (Rodrigues et al., 2024; Shallcross et al., 2022), particularly those involving children (Puka et al., 2020). Participants were provided with activities to practice independently between sessions, such as mindful daily activities and guided meditations recorded by the PI, including "body scan," sitting meditation, and breath awareness. These activities were to be practiced for at least five out of seven days each week, and participants were asked to record their practice on a log sheet, which was not required to be submitted.

2.4. Outcome measures

Four feasibility variables were considered: (1) recruitment rate and time, (2) adherence to the intervention, (3) satisfaction with the intervention, and (4) the impact of the intervention on PSWB.

To assess the effects of the intervention, quantitative psychological assessments were conducted immediately before the mindfulness intervention (pre-test, October 2022) and immediately after (post-test, December 2022). Tests were distributed to the parents, who ensured the intended participants completed them and returned them to the PI.

- *State-Trait Anxiety Inventory for Children (STAIC)*: A self-administered questionnaire used to assess state and trait anxiety levels in children and adolescents with ACH, comparing these levels before and after the intervention and between the control and experimental groups.
- *Multifactorial Self-Assessment Child Adaptation Test (TAMAI)*: A self-report measure for assessing general, personal, school, and social maladjustment; family and sibling dissatisfaction; appropriate parental education; educational discrepancies; self-image; and contradictions. It evaluates self-esteem, self-concept, and adaptation in various domains for children and adolescents with ACH, comparing results pre- and post-intervention and between groups.
- *Brief Symptom Inventory-18 (BSI-18)*: A self-administered tool that provides information on psychological symptoms across three

dimensions (somatization, depression, and anxiety) and a global severity index, assessing general distress. It is used to evaluate anxiety, depression, somatization, and overall well-being in parents, comparing results pre- and post-intervention and between groups.

Participants completed a Likert-type survey to assess satisfaction with the mindfulness intervention, with responses ranging from 0 (maximum dissatisfaction) to 5 (maximum satisfaction). The survey was administered online asynchronously in February 2023, using a link provided by the PI. The survey was based on the UVic-UCC teaching satisfaction questionnaire and included four items: (1) course design, (2) appropriateness of course duration, (3) trainer's subject knowledge, and (4) overall satisfaction with the course. An open-ended question for general comments was also included.

Qualitative data were collected through individual semi-structured online interviews conducted via *Zoom* four months after the intervention, in April 2024. The interviews aimed to explore participants' experiences and perceived long-term benefits regarding social, school, and family adaptation in children and adolescents with ACH, as well as the general well-being of their parents. While online interviews offer advantages regarding geographic flexibility and time efficiency, they may pose challenges in assessing participants' well-being and adjusting the interview approach if participants feel uncomfortable (Smith et al., 2022).

2.5. Data analysis

A mixed-methods approach was applied to assess the feasibility of the intervention and its impact on PSWB. Quantitative data were analysed using a pre-post design with a quasi-control group, employing *IBM SPSS Statistics V.29* for statistical analysis. Data were analysed separately for the two groups involved in the intervention: children and adolescents with ACH and their parents. Descriptive analyses were conducted for all variables at baseline (T0) and after intervention (T1), with qualitative variables, analysed through frequencies and percentages, and quantitative variables through means, standard deviations, and ranges. The Shapiro-Wilk test assessed the normal distribution of quantitative variables, recognizing that a small sample size might limit the likelihood of normal distribution. Within-group comparisons at each time point (T0 and T1) were conducted using the non-parametric Wilcoxon test to assess participant changes. The Mann-Whitney *U* test was employed for intergroup comparisons at each evaluation time point. A *p*-value < .05 was set as the level of statistical significance.

Sample size calculation was performed using the formula suggested by Fuentesaz Gallego (2004), assuming an α risk of .05 and a β risk of .20.

$$n = \frac{2(Z_{\alpha} + Z_{\beta})^2 S^2}{d^2}$$

where *n* refers to the total sample size, Z_{α} is the critical value of the normal distribution corresponding to the significance level α , and Z_{β} corresponds to the statistical power. *S* is the estimate of the population standard deviation, and *I* is the expected difference between the two means.

Given the lack of epidemiological data on the number of individuals with ACH in Catalonia, an estimate was derived by comparing the total number of children and adolescents in this region, within the study's age range, with the number of children born with ACH in the Valencian territory, based on the European epidemiological study by Coi et al. (2019). The estimate suggested that, in 2022, 27 individuals aged 8 to 15 had ACH in Catalonia. A confidence level of 95% indicated that all 27 individuals would need to be included in the intervention for the quantitative results to be generalizable to the entire study population.

Satisfaction survey data were collected via a *Microsoft Forms* survey linked to the UVic-UCC institutional account. Results were exported to

Microsoft Excel for analysis, including graphical representations of quantitative and qualitative responses to the open-ended question.

Qualitative data analysis involved a content review of the interview transcripts from participants who attended at least six mindfulness sessions. The data were examined separately for children and adolescents with ACH and their parents, using *Atlas.ti V.24* software for computer-assisted qualitative analysis. Transcripts were systematically coded and categorized, following a triangulation process among research team members to ensure reliability. Categories were refined to establish final classifications, and preliminary results were verified through content analysis and keyword retrieval in context.

3. Results

3.1. Participants

Eight (*n* = 8) children and adolescents with ACH and nine (*n* = 9) parents agreed to participate in the study. Six minors and seven parents participated in the mindfulness program, while two minors and two parents were in the control group. Among the mindfulness program participants, six children or adolescents with ACH were accompanied by one parent, except for one child whose parents were both accompanied. However, one child participant and their parent were excluded for not meeting the requirement of attending at least six sessions as stipulated in the inclusion criteria. Ultimately, seven children and adolescents with ACH (*n* = 7) and eight parents (*n* = 8) completed the mindfulness intervention and the study, resulting in a total of 15 participants (*N* = 15). The socio-demographic characteristics of the participants are presented in Table 1.

3.2. Feasibility results

Given that the number of individuals with ACH aged 8–15 years associated with AFAPAC was 19, according to the association's data, and eight participants initially enrolled in the study, the recruitment rate calculated was 42.1%. The approximate time spent on recruitment totalled 12 h. Of the 13 participants enrolled in the intervention, 11 completed the minimum of six required sessions, resulting in an adherence rate of 84.61%, with 83.33% adherence among participants with ACH and 85.71% among parents. Thirteen of the 15 participants completed the psychological assessments, satisfaction survey, and semi-structured interview, representing 86.66% of the participants.

Regarding session participation, each session involved six connections, assuming full attendance. Each connection typically included a child or adolescent with ACH and a parent, except for one instance where both parents accompanied a child. Attendance rates varied: two participants (minor and parent) attended only one session (12.5%); five participants (two minors and three parents) attended six sessions (75%); four participants (two minors and two parents) attended seven sessions (87.5%); and two participants (a child and parent) attended all eight sessions (100%). The main reasons for absence included family commitments, unspecified reasons, and one instance of unresolved technical issues.

Finally, eight participants completed the satisfaction survey, which accounts for 72.73% of the participants. Additionally, one parent completed the survey jointly with their child or adolescent, raising the indirect participation rate to 81.82%. The overall satisfaction rate was 93.75%, with the highest satisfaction being with the trainer (100%) and the lowest with the duration of the sessions (87.5%) (See Fig. 1). On the positive side, feedback included comments like "I really liked it" from a participant with ACH, and from parents: "Thank you for everything", "We would do it again", and "It has been a harmonious period, both physically and mentally, greatly enriching and providing tools for improvement". However, qualitative feedback also revealed dissatisfaction from one ACH participant, who found the sessions "very boring", and three of the five adult participants expressed a preference for some

Table 1
Sociodemographic characteristics of the participants.

Children and adolescents with ACH			
Population description	Control, n (%)	Experimental, n (%)	Total, n (%)
Sample Size	2 (28,57)	5 (71,43)	7 (100)
Sex			
Female	1 (50)	2 (40)	3 (42,85)
Male	1 (50)	3 (60)	4 (57,14)
Age, years			
8	1 (50)	1 (20)	2 (28,57)
9		1 (20)	1 (14,28)
10		1 (20)	1 (14,28)
12	1 (50)		1 (14,28)
14		1 (20)	1 (14,28)
Clinical trial, yes	1 (50)	2 (40)	3 (42,85)
Receives medication, yes	1 (50)	1 (20)	2 (28,57)
Previous knowledge of Mindfulness, yes	0 (0)	0 (0)	0 (0)
Number of family members			
Two	2 (100)	2 (40)	4 (57,14)
Three		1 (20)	1 (14,28)
Four		1 (20)	1 (14,28)
Five		1 (20)	1 (14,28)
Parents of children and adolescents with ACH			
Sample Size	2 (25)	6 (75)	8 (100)
Sex			
Female	1 (50)	5 (83,33)	6 (75)
Male	1 (50)	1 (16,66)	2 (25)
Age, years			
43		1 (16,66)	1 (12,5)
45		1 (16,66)	1 (12,5)
46		1 (16,66)	1 (12,5)
47		1 (16,66)	1 (12,5)
48		1 (16,66)	1 (12,5)
49	1 (50)		1 (12,5)
50	1 (50)		1 (12,5)
66		1 (16,66)	1 (12,5)
Previous knowledge of Mindfulness, yes	0 (0)	0 (0)	0 (0)
Education level			
School graduate	1 (50)	1 (16,66)	2 (25)
Professional formation	1 (50)		1 (12,5)
Bachelor's degree		2 (33,33)	2 (25)
High education		3 (50)	3 (37,5)
Employment status			
Full-time contract	1 (50)	4 (66,66)	5 (62,5)
Self-employed	1 (50)	1 (16,66)	2 (25)
Unemployed/retired		1 (16,66)	1 (12,5)
Marital status			
Married	2 (100)	5 (83,33)	7 (87,5)
Single		1 (16,66)	1 (12,5)

face-to-face interactions. Additionally, one parent mentioned the challenge of finding time for these activities due to a busy schedule.

3.3. Quantitative results

The quantitative results from the STAIC and TAMAI assessments administered to children and adolescents with achondroplasia (ACH), as well as the BSI-18 administered to their parents, are presented in Tables 2 and 3, respectively.

3.3.1. STAIC results for children and adolescents with ACH

Intragrupal results were evaluated through the comparison of means and the Wilcoxon test (see Table 2). Despite the lack of statistical significance, the results indicated a trend toward improvement in state anxiety, with a decrease in mean scores from the pre-intervention stage (T0) to the post-intervention stage (T1) (from 30.60 ± 5.12 to 26.80 ± 6.94 , $p = .225$). However, a slight increase in trait anxiety was noted (from 30.80 ± 5.21 to 32.60 ± 3.64 , $p = .285$). In the control group, the difference in state anxiety between T0 and T1 was minimal (from $24 \pm$

2.82 to 24.5 ± 2.12 , $p = .317$), while a slight decrease in trait anxiety was recorded (from 32.5 ± 6.36 to 30 ± 11.31 , $p = .655$).

When comparing intergroup results using means and the Mann-Whitney test, while the mean differences between the two groups did not reach statistical significance at any time point (T0 and T1), the experimental group exhibited a more pronounced reduction in state anxiety compared to the control group, which showed no variation. This is reflected in the more pronounced difference in means observed at pre-intervention ($p = .118$) compared to post-intervention ($p = 1.000$). The control group started with a lower mean than the experimental group (24 ± 2.82 vs. 30.60 ± 5.12), but after the intervention, the means became much closer (24.5 ± 2.12 vs. 26.80 ± 6.94) due to the reduction in the experimental group and the stability of scores in the control group.

3.3.2. TAMAI results for children and adolescents with ACH

Although the results did not reach statistical significance, they indicate slight trends toward improvement in the experimental group from T0 to T1, especially in personal maladjustment (from 5.60 ± 2.40 to 4.20 ± 1.48 , $p = .102$) and social maladjustment (from 6.20 ± 1.30 to 5.40 ± 3.57 , $p = .465$). Regarding maternal adequate education, there was also a slight trend toward improvement (from 66.00 ± 76.68 to 75.25 ± 75.2 , $p = .655$), which was more pronounced in paternal adequate education (from 65.40 ± 76.73 to 84.5 ± 86.60 , $p = .180$). Conversely, the results also indicate a slight increase in dissatisfaction with the family environment (from $.40 \pm .89$ to $.50 \pm 1.00$, $p = .317$) and dissatisfaction with siblings within the experimental group (from 1.33 ± 1.15 to 2.00 ± 2.00 , $p = .317$). Additionally, there was a slight increase in educational discrepancy (from 1.40 ± 1.67 to 2.00 ± 2.30 , $p = .317$) and a slight decrease in pro-image (from $6.20 \pm .83$ to 5.60 ± 1.51 , $p = .257$). In the control group, no significant difference was observed between T0 and T1 in most domains, with only minor changes noted in the remaining domains (paternal and maternal adequate education), where values slightly increased at T1.

The intergroup comparison using means and the Mann-Whitney test revealed that, at T0, there was minimal difference between the values of both groups, except in the domain of educational discrepancy, where the control group's values were $.00 \pm .00$ at both T0 and T1. In contrast, the experimental group's values were 1.40 ± 1.67 , resulting in an intergroup difference of $p = .200$ at T0, which shifted to 2.00 ± 2.30 , $p = .264$ at T1. However, the most significant variation between the two groups occurred in the pro-image domain, where the experimental group started at T0 with higher values ($6.20 \pm .83$) compared to the control group (3 ± 1.41), resulting in a statistically significant intergroup difference ($p = .049$). This difference decreased at T1 ($p = .076$) because the control group's values remained unchanged while the experimental group's values decreased.

3.3.3. BSI-18 results for parents of children and adolescents with ACH

For the parents (see Table 3), trends toward improvement were observed, although not statistically significant, particularly in the comparison of means within the experimental group from T0 to T1 using the Wilcoxon test. These improvements were noted in somatization (from 3.67 ± 3.98 to 2.33 ± 2.25 , $p = .197$), the global severity index (from 8.67 ± 8.59 to 6.00 ± 5.21 , $p = .273$), and especially in anxiety, where the improvement approached statistical significance (from 3.67 ± 3.93 to $1.00 \pm .89$, $p = .066$). It should be noted that one participant in the experimental group exhibited a ceiling effect by responding to all items with the maximum favorable value at both T0 and T1. However, the results also showed a slight increase in depression (from 1.33 ± 1.21 to 2 ± 2.44 , $p = .705$). In the control group, there was no difference in values from T0 to T1 in depression and the global severity index ($p = 1$), while there was a slight decrease in somatization values (from $.50 \pm .70$ to $.00 \pm .00$, $p = .317$) and an increase in anxiety (from $.00 \pm .00$ to $1 \pm .70$, $p = .317$).

The intergroup comparison, utilizing means and the Mann-Whitney

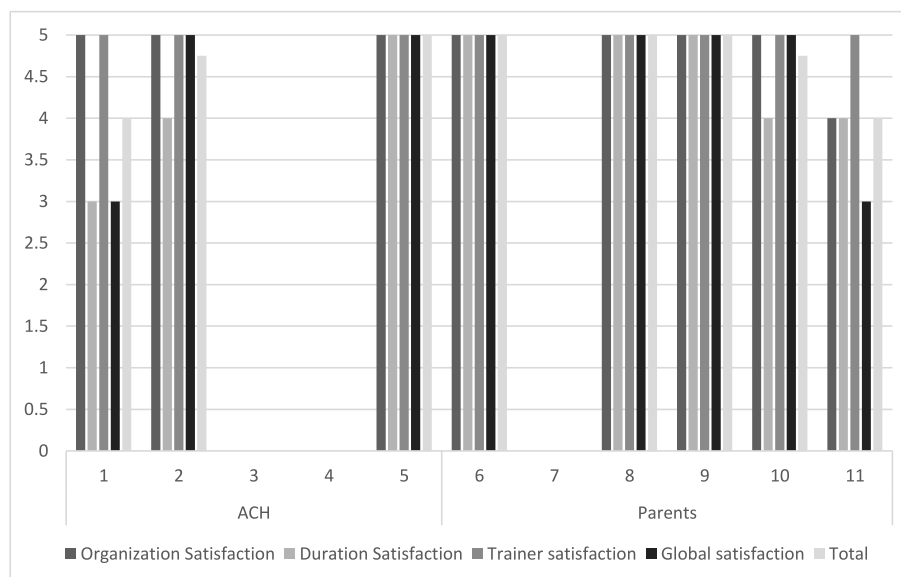


Fig. 1. Satisfaction survey of children and adolescents with ACH and their parents.

Table 2

Comparative analysis between and within children and adolescents ACH groups.

	Group	Pre-intervention (T0)		Post-intervention (T1)		Wilcoxon
		Average \pm SD	U Mann-Whitney U	Average \pm SD	U Mann-Whitney U	
STAIC			<i>Z (p)</i>			<i>Z (p)</i>
Trait	Experimental	30.80 \pm 5.21	-.197 (.844)	32.60 \pm 3.64	-.391 (.696)	-1.069 (.285)
	Control	32.5 \pm 6.36		30 \pm 11.31		-.447 (.655)
State	Experimental	30.60 \pm 5.12	-1.563 (.118)	26.80 \pm 6.94	.000 (1.000)	-1.214 (.225)
	Control	24 \pm 2.82		24.5 \pm 2.12		-1.000 (.317)
TAMAI			<i>Z (p)</i>			<i>Z (p)</i>
General maladjustment	Experimental	20.80 \pm 9.98	.000 (1.000)	20.20 \pm 6.14	.000 (1.000)	.000 (1.000)
	Control	24.5 \pm 23.33		24.5 \pm 23.33		.000 (1.000)
Personal maladjustment	Experimental	5.60 \pm 2.40	-.195 (.845)	4.20 \pm 1.48	-.391 (.696)	-1.633 (.102)
	Control	7 \pm 5.65		7 \pm 5.65		.000 (1.000)
School maladjustment	Experimental	10.00 \pm 7.07	-.387 (.845)	10.60 \pm 4.50	.000 (1.000)	-.365 (.715)
	Control	8.5 \pm 12.02		8.5 \pm 12.02		.000 (1.000)
Social maladjustment	Experimental	6.20 \pm 1.30	-.387 (.845)	5.40 \pm 3.57	-1.172 (.241)	-.730 (.465)
	Control	9 \pm 5.65		9 \pm 5.65		.000 (1.000)
Dissatisfaction with family environment	Experimental	.40 \pm .89	-.632 (.527)	.50 \pm 1.00	-.707 (.480)	.000 (1.000)
	Control	.00 \pm .00		.00 \pm .00		.000 (1.000)
Dissatisfaction with siblings	Experimental	1.33 \pm 1.15	-.333 (.739)	2.00 \pm 2.00	-.609 (.543)	-1.000 (.317)
	Control	1 \pm 1.41		1 \pm 1.41		.000 (1.000)
Father's Adequate education	Experimental	65.40 \pm 76.73	-.000 (1.000)	84.5 \pm 86.60	-.235 (.814)	-1.342 (.180)
	Control	83.5 \pm 108.18		84 \pm 107.48		1.000 (.317)
Mother's adequate education	Experimental	66.00 \pm 76.68	-.402 (.688)	75.25 \pm 75.2	.814 (.800)	-.447 (.655)
	Control	78.5 \pm 101.11		79 \pm 100.40		1.000 (.317)
Educational discrepancy	Experimental	1.40 \pm 1.67	-1.282 (.200)	2.00 \pm 2.30	-1.118 (.264)	-1.000 (.317)
	Control	.00 \pm .00		.00 \pm .00		.000 (1.000)
Pro-image	Experimental	6.20 \pm .83	-1.972 (.049)	5.60 \pm 1.51	-1.775 (.076)	-1.134 (.257)
	Control	3 \pm 1.41		3 \pm 1.41		.000 (1.000)
Contradictions	Experimental	2.60 \pm .89	-.966 (.334)	2.40 \pm 1.51	.000 (1.000)	-.272 (.785)
	Control	2 \pm .00		2 \pm .00		.000 (1.000)

test, indicated that participants in the experimental group had notably higher values in all domains at T0, particularly in anxiety ($p = .086$). In contrast, the control group's mean values were nearly null, with $.00 \pm .00$ in both depression and anxiety; and $.5 \pm .70$ in somatization and the global severity index. At T1, the difference in anxiety decreased substantially ($p = .480$), as the experimental group's values decreased (from 3.67 ± 3.93 to $1.00 \pm .89$) and the control group's values increased (from $.00 \pm .00$ to $1 \pm .70$). In the remaining domains, the differences between the two groups remained nearly unchanged.

3.4. Qualitative results

Both populations reported beneficial effects of mindfulness on their PSWB, particularly in the categories of emotional regulation, personal growth, and general well-being. Family relationships were infrequently mentioned, especially by children and adolescents with ACH, and social relationships were also underreported, particularly by parents. Despite being less frequently mentioned, these categories were significant for some participants.

3.4.1. Effects of mindfulness on children and adolescents with ACH

Among the five child and adolescent participants, two (P2 and P5)

Table 3

Comparative analysis between and within parents of children and adolescents ACH group.

	Group	Pre-intervention (T0)		Post-intervention (T1)		Wilcoxon
		Average \pm SD	U Mann-Whitney U	Average \pm SD	U Mann-Whitney U	
BSI-18			<i>Z (p)</i>			<i>Z (p)</i>
Somatization	Experimental	3.67 \pm 3.98	−1.349 (.177)	2.33 \pm 2.25	−1.430 (.153)	−1.289 (.197)
	Control	.50 \pm .70		.00 \pm .00		−1.000 (.317)
Depression	Experimental	1.33 \pm 1.21	−1.430 (.153)	2.00 \pm .244	−1.430 (.153)	−.378 (.705)
	Control	.00 \pm .00		.00 \pm .00		.000 (1.000)
Anxiety	Experimental	3.67 \pm 3.93	−1.719 (.086)	1.00 \pm .89	−.706 (.480)	−1.841 (.066)
	Control	.00 \pm .00		1 \pm .70		−1.000 (.317)
Global Severity Index	Experimental	8.67 \pm 8.59	−1.518 (.129)	6.00 \pm 5.21	−1.509 (.131)	−1.095 (.273)
	Control	.50 \pm 707		.50 \pm 70		.000 (1.000)

reported benefits in all categories of PSWB. One participant (P3) noted improvements in all categories except for family relationships, and another (P4) noted improvements in all categories except family and social relationships. Notably, one participant (P1) cited only one benefit in the category of emotional regulation, responding negatively to most questions.

The most reported category was emotional regulation (31.40%, $n = 5$), followed by personal growth (29.07%, $n = 4$) and general well-being (27.91%, $n = 4$), representing 88.38% of the perceived PSWB benefits. Social relations (9.30%, $n = 3$) and family relations (2.33%, $n = 2$) were the least reported categories, accounting for 11.62% of the perceived benefits (see Fig. 2).

3.4.2. Emotional regulation

Emotional regulation, consisting of 12 codes, was the most mentioned category (31.4%, $n = 5$), and all participants cited codes related to it (27 mentions). The most frequently mentioned subcategories were coping strategies (17.48%, $n = 5$), followed by self-control (15.53%, $n = 4$), changes in thinking (12.62%, $n = 4$), and anxiety regulation (12.62%, $n = 4$), and a decrease in recurrent thoughts (11.65%, $n = 4$). Although mentioned less frequently, resilience was cited by all participants (8.74%, $n = 5$).

Participant P2 described how mindfulness helped with emotional regulation: "In crowded places, if I go alone, I don't like it. But mindfulness, with breathing and things like that, and thinking that nothing is happening, has helped me", and "when I'm very nervous, I do the breathing exercises and it dampens my nervousness and emotions", as well as "it has also helped me not to criticize myself as much, to accept

my mistakes without insulting myself". P3 mentioned it helped with "when a person looks at me badly". P4 stated, "I have learned to live in the moment [...] especially on Sundays, not to worry about Monday; that's where I've noticed it the most". P5 added, "I used to dwell a lot on things I didn't like or things I didn't do well, and mindfulness helps me with that".

3.4.3. Personal growth

Personal growth, which included eight codes, was the second most frequently mentioned category (29.07%, $n = 4$), with 25 mentions. This category was particularly relevant for three participants: P2 (42.50% of mentions), P3 (27.5%), and P4 (25%), comprising 95% of the citations in this category. P1 did not cite any benefits in this category, and P5 cited 5%.

The most mentioned codes in this category were personal learning (23.75%, $n = 3$), self-care (18.75%, $n = 4$), positive habits (15%, $n = 3$), and personal development (12.50%, $n = 3$). Other notable mentions included positivity (10%, $n = 4$), self-knowledge (10%, $n = 3$), and self-reflection (8.75%, $n = 2$). The least reported was self-efficacy (1.25%, $n = 1$).

P2 described personal growth by saying, "I try to put aside the negative comments I make towards myself, not criticize myself, and learn to improve my way of expressing myself." And "when I'm taking an exam, I take a deep breath and think I'll do well." P3 noted, "in situations where negative things happen with my friends, I think that maybe I'm focusing on the negative." P4 mentioned, "I was very bored in class, and now I've learned not to be so bored," and "I liked when we experimented in the sessions, like the ice, raisin, or drawing exercises."

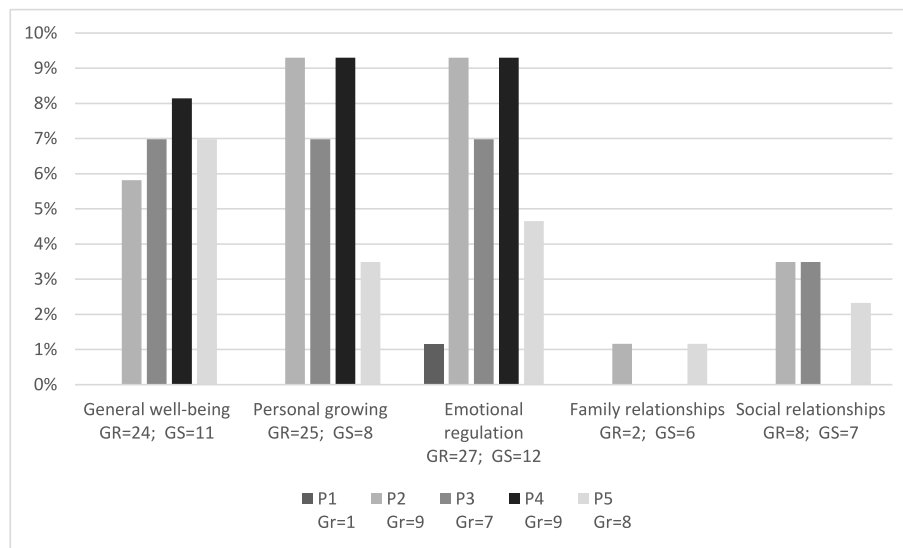


Fig. 2. Percentage of categories reported by children and adolescents with ACH
Abbreviations: GR, number of reported quotes; GS, number of codes associated with the category; P, participants.

3.4.4. General well-being

General well-being, encompassing 11 codes, was the third most reported category (27.91%, $n = 4$), with 24 mentions. The most frequently mentioned codes were well-being (22.58%, $n = 4$), quality of life (14.52%, $n = 4$), and relaxation (11.29%, $n = 4$). Emotional satisfaction and mental health were each mentioned with a frequency of 9.68% ($n = 4$). Combining mentions of relaxation, tranquillity, and rest, which are closely related to calmness, represent 24.2% ($n = 4$) of the mentions.

For example, P2 noted, "It has helped me to be more relaxed and worry less." P3 added, "When I go to bed, I use relaxation techniques and sleep more peacefully." P4 stated, "When I'm nervous, I concentrate on my body, and then I relax." P5 said, "I use the body scan to feel calmer."

3.4.5. Social and family relationships

These two categories were significantly less mentioned than the previous three, with social relations accounting for 9.30% ($n = 3$) of the mentions and family relations accounting for 2.33% ($n = 2$). Two participants (P1 and P4) did not mention any codes in social relations. The remaining participants highlighted social interaction and personal relationships (29.17%, $n = 3$) as the most relevant. Positive effects on interpersonal conflicts were mentioned 16.67% of the time ($n = 2$).

In family relationships, only participants P2 and P5 mentioned them, with positive family interaction and family relationships being the most prominent (28.57%, $n = 2$). Other notable mentions included positive family bonding, family empathy, and positive family connection (14.29%, $n = 1$ each).

Regarding an interpersonal conflict in class, P2 commented, "mindfulness has helped me tolerate it more, and not be so rude to them [...] lately, I'm trying to get along better with them, and they don't disrespect me either." P5 mentioned feeling calmer and more relaxed about other people.

3.5. Effects of mindfulness on parents' PSWB

All participants reported positive effects on their PSWB. Nevertheless, while half (P7, P8, and P9) expressed improvements in each of the five PSWB categories, the other half (P6, P10, and P11) noted at least one category, particularly family relationships, where they did not perceive improvement. Social relations were also less frequently mentioned by some participants, with both categories representing 15.56% of mentions, while general well-being, personal growth, and emotional regulation accounted for 84.45%.

Participant differences were noted, with one individual (P8) reporting the most extensive positive effects, representing 37.04% of the reported improvements. Other participants reported moderate improvements (P7: 20%, P9: 17.78%, P6: 12.59%), while P10 and P11 reported fewer improvements than others (5.19% and 7.41%, respectively). At least one participant reported 44 mentions spread across the five categories (see Fig. 3).

3.5.1. General well-being

General well-being, comprising 12 codes, was the most frequently expressed category (40 mentions), representing a significant portion (29.63%, $n = 6$) of the total categories. The most frequently mentioned codes were improvements in well-being (20.61%, $n = 6$) and quality of life (19.08%, $n = 6$), both of which, along with emotional satisfaction (12.98%, $n = 6$) and relaxation (6.11%, $n = 6$), were reported by all participants. Other notable mentions included improved mental health (13.74%, $n = 4$) and gratitude (12.21%, $n = 4$), with four participants reporting these aspects.

Participant P7 commented on the importance of "stopping, taking a few minutes to breathe, to reconnect with yourself, to live in the present, not to let the day-to-day grind take over [...] when you do it, it's great, and I don't know why daily life eats away at you." This sentiment was echoed by P9, who noted, "yes, while I was doing it and following the practices ... Which I no longer do (laughs) [...] it was very noticeable." P6 mentioned, "If you're making a coffee [...] feeling the heat when you drink it, the cup, how beautiful it is ... [...] you see it differently, and the brain rests."

Tranquillity (6.11%, $n = 5$) and rest (3.05%, $n = 3$) were also notable, as all participants mentioned at least one of these quotes. When combined with relaxation (6.11%, $n = 6$), these represent 15.27% of mentions related to calmness. For example, P6 noted, "You feel better ... You sleep better [...] being able to sleep more peacefully, with the meditation audios [...] and thus you are more rested the next day [...] I would encourage everyone to do it, clearly (laughs)." P9, when asked if they perceived improvements in their well-being, replied emphatically, "yes, yes, yes, and so much!" and mentioned that their child seemed "more peaceful, but above all, seeing them calmer [...]" and that mindfulness "helps you feel better [...] contributes to well-being."

3.5.2. Personal growth

Personal growth, which involved eight codes, was the second most frequently mentioned category (27.94%, $n = 6$), with 38 mentions. This

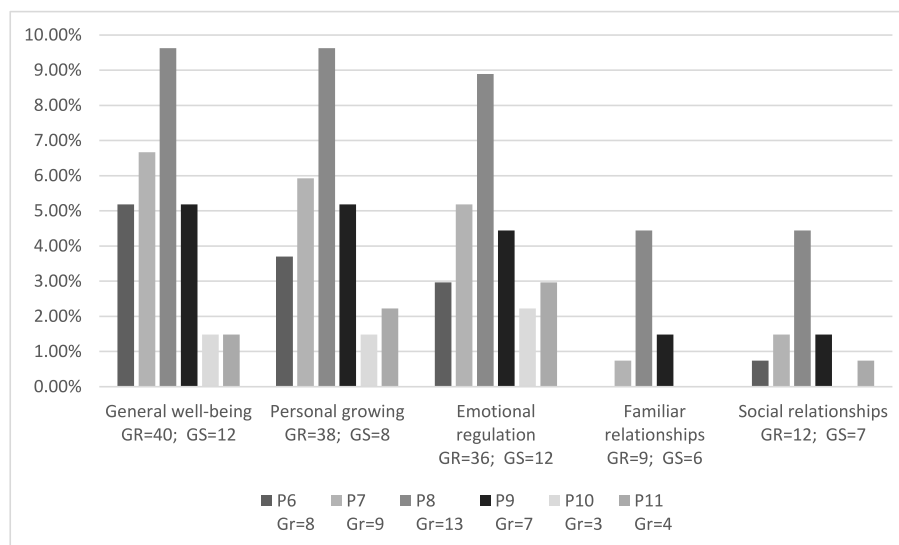


Fig. 3. Percentage of categories reported by parents of children and adolescents with ACH
Abbreviations: GR, number of reported quotes; GS, number of codes associated with the category; P, participants.

category was characterized by the least variation in the percentage between codes, making it the most balanced category overall.

The most frequently mentioned codes were personal learning (16.56%, $n = 6$), self-reflection (15.92%, $n = 6$), and positive habits (15.29%, $n = 6$), which were reported by all participants. For example, P8 noted they had learned to "take care of themselves" and "when you realize you're on autopilot, and you say I don't want that!" P9 mentioned, "I have learned to breathe consciously [...] stop, reflect, accept what has to come," and "body scan, I do it to release tension [...] scanning the pain so that it dissipates, so it doesn't hurt as much [...] it has helped me a lot." P10 said, "especially when you see that if you had done something consciously, you would have done it differently." P6 added, "I have learned to enjoy the moments!"

Other aspects mentioned included self-care (14.01%, $n = 5$), personal development (12.74%, $n = 4$), self-knowledge (10.83%, $n = 4$), positivity (7.01%, $n = 4$), and self-efficacy (7.01%, $n = 3$). Although these were the least reported, personal growth was the most balanced category overall, with codes generally reported by four of the six participants.

3.5.3. Emotional regulation

Emotional regulation, consisting of 12 codes, was the third most frequently mentioned category (26.67%, $n = 6$), with 36 mentions. In this category, several codes were mentioned by all participants: changes in thinking (13.53%, $n = 6$), emotional self-regulation (12.35%, $n = 6$), self-control (11.76%, $n = 6$), coping strategies (8.82%, $n = 6$), living in the present, and full awareness in the present (8.24%, $n = 6$, respectively). Self-awareness, although mentioned by four participants, had a high percentage (10.59%, $n = 4$), particularly by one participant (P8), who mentioned it eight times, representing 44% of the mentions related to this code. P8 noted, "Well-being care, for me, this is the most positive part I get from mindfulness. It is a cure on an emotional level ... And on a physical level." P9 added, "Sometimes finding that moment in the evening to reflect a little, to say how it went, what I did. Well, in the end, you end up feeling better about yourself as well." P11 commented, "I try to concentrate on what I'm doing to do it more consciously."

3.5.4. Social and family relationships

As mentioned, these two categories were the least frequently reported, with social relations accounting for 8.89% ($n = 4$) of the mentions and family relations accounting for 6.67% ($n = 3$). These were the only two categories where not all participants perceived effects.

In the case of social relations, the most frequently mentioned codes were improvements in social relations and interactions (37.5%, $n = 5$), followed by the importance of collaborative learning and sharing experiences during the course (21.88%, $n = 3$ each). Effects on social empathy (12.50%, $n = 3$) and conflict management (6.25%, $n = 2$) were less frequently mentioned. P6 noted, "it's nice to do it in a group, to share experiences [...] it was positive."

In the case of family relationships, only two participants (P8 and P9) mentioned effects, with positive family connection being the most frequently cited (28%, $n = 3$). P8 commented, "It was a positive connection." P9 added, "Being able to have this activity as a family [...] is very positive [...] it is super important [...] at the end of the session you spoke [...] I liked having learned together [...] it was a moment that we really had for ourselves [...] this for me is the best."

3.6. Comparison of results in childhood and adolescence with ACH and their parents

The results for both populations showed notable positive effects in the categories of general well-being, emotional regulation, and personal growth. In contrast, social and family relationships were less frequently mentioned, especially in the child and adolescent population with ACH. Furthermore, more benefits were coded for the parents (514) than for their children (293), suggesting a greater impact on their PSWB, possibly

due to the greater maturity of their answers or reflections. However, it should be considered that there was one more parent participant, and among the children and adolescents, one participant barely cooperated during the interview. Both parents and children highlighted personal learning, well-being, self-care, emotional self-regulation, changes in thinking, positive habits, personal development, calmness, and quality of life as the most relevant aspects. They differed in that, for minors, coping strategies (2nd place), anxiety regulation, reduction of recurrent thoughts, and resilience were highly mentioned, while for parents, self-reflection (3rd place), self-awareness, mental health, and self-knowledge were more relevant.

4. Discussion

The aim of this study was to evaluate the feasibility and potential effects of an MBCT-based mindfulness program on the PSWB of children and adolescents with ACH and their parents. Overall, the results indicate that conducting an online mindfulness intervention for these populations is both feasible and potentially effective, particularly in reducing anxiety and enhancing general well-being, emotional regulation, and personal growth.

4.1. Feasibility of the study

The findings suggest that the online intervention was well accepted, with high adherence rates regarding session attendance and research activity participation. Specifically, 84.61% of participants completed the minimum of six required sessions, a rate that surpasses those reported in similar interventions, such as 43% and 52% in Flynn et al. (2020) and 64% in Shallcross et al. (2022). This rate is comparable to adherence levels observed in face-to-face interventions (85–90%), as reported in Shallcross et al. (2022). The overall satisfaction rate was 93.75%, with trainer satisfaction reaching 100%. This highlights the importance of the trainer's role in fostering adherence and satisfaction, as suggested by Marks et al. (2023), where participant motivation and adherence are closely tied to the facilitator's credibility and personal engagement. However, it is important to note that the small sample size, the non-anonymous data collection, and the potential desirability bias, as exemplified by the Hawthorne effect (Elston, 2021), may have compromised the validity of the results and affected the generalizability of the study's findings.

The small sample size ($n = 15$) was dictated by the unique population of children and adolescents with achondroplasia, a rare condition that significantly restricts the target population and, consequently, the achievable sample size, particularly in a territory like Catalonia, with a population of 7.7 million in 2022 (Idescat, 2024). The additional focus on a paediatric cohort further narrows the pool of eligible participants, impacting the statistical power to detect subtle effects and limiting the generalizability of the findings. Although our results provide valuable preliminary insights into this specific group, they should be interpreted with caution due to the limited sample size. Future research could address these limitations by employing larger, multicentre samples, potentially including children and adolescents with related skeletal dysplasias resulting in disproportionate short stature to enhance statistical power, as demonstrated in previous studies (Dhiman et al., 2017; Jennings et al., 2019; Hunter, 1998b; Quitmann et al., 2015, 2016; Silva et al., 2018). Such approaches would support a more comprehensive understanding and improve greater external validity for the intervention.

Furthermore, the recruitment rate was moderate, with 42.1% of the 19 eligible participants with ACH enrolling in the study. Although this is nearly double that reported in similar studies (22%) by Shallcross et al. (2022), it remains lower than the 58% observed by Flynn et al. (2020). Additionally, the recruitment rate might have been higher if participation had been free or financial compensation had been offered, as noted in other studies (Flynn et al., 2020; Lo et al., 2024; Shallcross et al.,

2022). Future studies may consider enhancing recruitment by removing financial costs associated with programme participation or even by offering a financial incentive for enrolment and participation. However, it would be preferable for motivation to stem from the intrinsic benefits of mindfulness, ensuring participants are genuinely interested in learning and experiencing its advantages.

The online format facilitated accessibility for a geographically dispersed population but presented certain challenges and limitations. Some participants expressed a preference for face-to-face sessions, consistent with findings by Marks et al. (2023). Additionally, online format reduced social contact between participants and between participants and the instructor, which may influence the psychosocial benefits of the intervention and engagement with the programme. Although activities were incorporated to foster interaction, such as breakout room facilitated via Zoom, and one participant (P6) highlighted the perceived benefits of these interactions as well as sharing a family activity (P8, P9). Nevertheless, online intervention cannot fully replicate the experience of in-person interaction. This is especially important in a population that values social contact with peers, as described in their evaluations of organisational support (Pfeiffer et al., 2020a, 2020b, 2021a, 2021b; Shediach et al., 2022). Although technical difficulties were minimal, one participant could not attend a session due to these issues. This is not uncommon in online interventions and may relate to participants' technical skills. Providing clear instructions or rehearsals before starting the program could mitigate such problems (Marks et al., 2023). Future studies might consider a hybrid format, combining online and face-to-face sessions, to assess which approach yields better results.

Regarding group size, as far as we know there is no established criterion for the number of participants in online mindfulness interventions, with studies ranging from four to eight participants (Puka et al., 2020) to as many as 30 (Lunsky et al., 2021). This study's small number of participants ($n = 11$) facilitated a dynamic and engaging group experience. However, some participants informally mentioned at the start of sessions that they had not completed the exercises at home. As noted by Parsons et al. (2017), compliance with home practice tends to be around 60% when exercises are reported and delivered. Therefore, it may be beneficial for participants to submit their activity logs to the trainer, as this could motivate them to complete the exercises, which are a crucial component of mindfulness programs and contribute to the intervention's success (Parsons et al., 2017). Moreover, data collection posed challenges, as the online administration of psychological tests meant that children and adolescents did not report their results directly but through their parents, which may introduce a bias in the responses. Given that one of the tests (TAMAI) included questions related to family satisfaction and education, this could have further influenced the results. To improve data integrity, future studies could administer psychological tests face-to-face during the first and last sessions, with post-test and satisfaction questionnaires completed immediately after the final session and ensuring anonymity. Online interviews, despite their drawbacks (Smith et al., 2022), offer time-saving benefits and reduce participant burden, making them a viable option for future studies.

4.2. Effects on PSWB

The intervention appeared to benefit both populations, particularly in reducing anxiety and enhancing general well-being, emotional regulation, and personal growth. These findings align with previous studies (Galante et al., 2023; Oñate and Calvete, 2019; Osborn et al., 2021; Xie et al., 2021). Some participants acknowledged the difficulty of maintaining regular mindfulness practice four months after the course, a challenge also noted in other studies (Flynn et al., 2020; Marks et al., 2020). The reported barriers included time constraints, commitments, and workload, consistent with findings from the systematic review by Marks et al. (2023). Additionally, individual differences and the

perceived difficulty of exercises could pose challenges, as mindfulness, while simple, is not easy (Kabat-Zinn, 2013).

Although few participants mentioned practicing mindfulness in daily activities, such as eating or walking mindfully, many reported using breathing techniques in stressful situations and practicing body scans to relax before sleep. This suggests that the enhanced ability to relax, frequently mentioned in the interviews, may have contributed to the observed decrease in anxiety, particularly among parents, where anxiety reduction approached statistical significance despite the small sample size (Xie et al., 2021). In children and adolescents with ACH, the qualitative results highlighted benefits related to personal growth, emotional regulation, and general well-being. These outcomes are particularly relevant given the negative impacts on PSWB reported in previous studies on children and adolescents with ACH (Bedeschi et al., 2023; Csapo, 1991; Galasso et al., 2019; González and Hernández, 2001; Lorne et al., 2020; Okenfuss et al., 2020; Shediach et al., 2022; Witt et al., 2017, 2019). Furthermore, these benefits may also align with findings that coping strategies improve with age (Ireland et al., 2011; Nishimura and Hanaki, 2014; Witt et al., 2017). Although the quantitative results indicated a trend toward reduced personal and social maladjustment, as well as an increase in mothers' and fathers' adequate education in the experimental group, these findings may reach statistical significance with a larger sample. However, the data also suggested a slight tendency toward increased dissatisfaction with the family environment and siblings, which, although possibly influenced by the small sample size, is reflected in the qualitative results, where most minors did not perceive benefits in family relationships. These findings align with Xie et al. (2021), who found that well-being and family functioning improvements were not statistically significant due to sample size limitations. Moreover, improvements in self-esteem were not widespread, with few mentions of self-acceptance in the qualitative results and a slight decrease in the 'pro-image' item in the quantitative findings after the intervention. Previous studies have highlighted low self-esteem and self-acceptance in ACH (Bedeschi et al., 2023; Csapo, 1991; González and Hernández, 2001; Lorne et al., 2020; Pfeiffer et al., 2020a; Shediach et al., 2022), and there is evidence that some participants may not perceive benefits from mindfulness or may even experience disadvantages (Galante et al., 2023). Additionally, some studies do not show significant improvements in certain domains, such as depression, as Osborn et al. (2021) reported, where six of eight studies found no effect in one or more domains.

For parents, the intervention primarily benefited anxiety reduction, general well-being, personal growth, and emotional regulation, despite a slight increase in depression scores, which was statistically insignificant and likely attributable to the small sample size. One participant exhibited a ceiling effect, selecting the highest well-being levels on all pre- and post-intervention items, which may have influenced the quantitative results, especially considering that mindfulness studies tend to show greater improvements in stress and depression when baseline levels are higher (Osborn et al., 2021). Nonetheless, the qualitative results suggest that mindfulness may help parents combat the negative impacts associated with raising a child with ACH (Cormier-Daire et al., 2021; Csapo, 1991; González and Hernández, 2001; Hill et al., 2003; Pfeiffer et al., 2021b,a; Witt et al., 2019), consistent with findings in parents of children with other disabilities or similar conditions (Backeljauw et al., 2021; Hunter, 1998a; Quitmann et al., 2016; Witt et al., 2023; Young et al., 2020). Moreover, these qualitative results align with the quantitative findings, which showed a trend toward reduced anxiety, all of which suggest an improved quality of life post-intervention. These results align with studies reporting reduced stress following mindfulness interventions (Basso et al., 2019; Burgdorf et al., 2019; Osborn et al., 2021), though other studies have found no evidence that mindfulness reduces distress compared to active control groups (Galante et al., 2023). Xie et al. (2021) also note that parents of children with developmental issues may find it more difficult to perceive the benefits of mindfulness. These findings warrant further investigation

with larger samples to confirm the observed effects.

Social and family relationships areas were under-reported, particularly in interviews with children and adolescents with ACH. This difference compared to other categories may be attributed to a favorable social environment among participants, who were accustomed to engaging in AFAPAC activities, which have documented benefits for individuals with short stature and their parents involved in such organisations. Furthermore, the protective and committed family environment, with families willing to dedicate time to an eight-week programme aimed at enhancing well-being, likely contributed to these findings. Additionally, more specific questions about family and social interactions could be incorporated into the interviews, rather than relying solely on general questions about effects on the social and family environment. For instance, questions could focus on satisfaction with friends or family dynamics, the ease of interaction, or strategies for managing conflicts. Although positive effects on family and social relationships were reported less frequently, these areas held significance for some participants. Three parents found sharing mindfulness practice within the family particularly valuable, and two children echoed this sentiment, with one child observing that their mother seemed calmer. This reciprocal observation from both parents and children suggests that practicing mindfulness together can have a positive impact, particularly for children. Indeed, these findings align with [Osborn et al. \(2021\)](#), who noted that receiving parental attention and love positively affects children's PSWB and QoL ([Kidder and King, 2022](#)). Additionally, mindfulness practice within families has been shown to have multiple benefits ([Bögels et al., 2021](#); [Burgdorf et al., 2019](#); [Myers et al., 2023](#); [Xie et al., 2021](#)), especially in cases like ACH, where parents play a crucial role in shaping their children's self-esteem ([Abлон, 1990](#); [Ajimi et al., 2022](#); [Bedeschi et al., 2023](#); [Cormier-Daire et al., 2021](#); [González and Hernández, 2001](#)).

Although the effects on social relationships were infrequently mentioned, they were relevant to all but one parent and all but two children. Both groups highlighted the perceived benefits of conflict resolution, which are essential for enhancing PSWB and QoL and promoting social inclusion, as noted by [Hwang et al. \(2024\)](#) in their study on the effects of mindfulness on social inclusion in disability contexts. This is particularly important considering the negative impact of social scrutiny on the PSWB of individuals with ACH ([Csapo, 1991](#); [Gollust et al., 2003](#); [González and Hernández, 2001](#); [Lorne et al., 2020](#); [Pfeiffer et al., 2020a, 2021b](#); [Shediac et al., 2022](#); [Witt et al., 2017, 2019](#)). It is important to emphasize that the social environment's acceptance of diversity significantly influences the PSWB of individuals with chronic conditions. Indeed, social acceptance of conditions like ACH varies across cultures, as evidenced by differing attitudes toward limb-lengthening surgery. Thus, this type of intervention is widely rejected in the United States of America (USA), where it is estimated that only 1.2% of cases undergo surgery, while in Japan, this rate is 60%, and in Spain, it is estimated to be as high as 90% ([Hoover-Fong et al., 2021](#)), coinciding with [Cortinovis et al. \(2011\)](#), [Fernández et al. \(2012\)](#), and [Shediac et al. \(2022\)](#), suggesting that in some countries the acceptance of ACH status is prioritized more than in others. This variation suggests that societal acceptance of ACH status plays a critical role in the PSWB of children, adolescents, adults with ACH, and their parents.

4.3. Limitations of the study

This study has several limitations that should be acknowledged. The most prominent limitation is the small sample size, which inherently restricts the generalizability of the findings to the wider population of individuals with ACH and their parents. Furthermore, the lack of anonymity in data collection and the involvement of the PI at multiple stages of the study—ranging from course introduction and participant recruitment through the association to delivering the intervention and administering the psychological assessments and satisfaction surveys—may have influenced participant responses due to social

desirability bias and the Hawthorne effect with the risk that participants responses were influenced by what they assumed would be preferable to the PI or from not wanting to disappoint this person. These factors may affect the validity of the results, possibly leading to biased answers. However, the variability of the participant responses and the qualitative and quantitative differences in perceived effects suggest that some participants felt free to express their perceptions and feelings. The non-anonymous nature of the surveys further compounds this issue, potentially affecting the validity of the reported outcomes. The online format, while advantageous for enhancing accessibility, may have compromised the quality of interaction for certain participants, some of whom expressed a preference for more in-person sessions. Despite high adherence rates, it is noteworthy that not all participants consistently completed the home practice assignments, which could have impacted the study's overall results. Additionally, the implementation of measurement instruments primarily online, with parents having access to their children's questionnaires, may have introduced reporting biases, potentially skewing the perceived experiences and benefits.

Lastly, the study's lack of a more closely matched randomized control group presents a significant limitation. The absence of a well-matched control group compromised the attribution of the observed effects to the intervention, as the control group was composed of individuals who chose not to participate in the intervention, possibly creating baseline differences in motivation or even personal, social, or family characteristics in comparison with the participants in the programme. This made them less comparable than a control group created through random assignment, where characteristics could be more closely aligned with those of the experimental group, providing a more robust comparative framework. Such an approach would enhance the ability to attribute observed effects specifically to the intervention, thereby increasing the validity of the results.

4.4. Suggestions for future studies

Future research should explore the effects of mindfulness in adults with ACH and compare these results with those observed in younger populations. It would also be valuable to examine gender differences in the perception and effects of mindfulness related to ACH, both in patients and parents. Moreover, studying the social perception of ACH across different cultures and understanding its impact on the PSWB of individuals with this condition would provide valuable insights.

5. Conclusion

This study confirms the feasibility of an online mindfulness intervention, with high adherence and satisfaction rates. However, some participants preferred face-to-face sessions, suggesting that future studies should explore hybrid formats. In summary, the findings provide evidence that an MBCT-based mindfulness intervention can improve PSWB in children and adolescents with ACH, particularly by reducing anxiety and enhancing general well-being, emotional regulation, and personal growth while decreasing general, personal, and social maladjustments.

Parents also experienced significant improvements in PSWB, with notable reductions in anxiety and somatization, along with increased general well-being, emotional regulation, and personal growth. Family mindfulness practice provided a valuable opportunity for household members to connect, though improvements in social and family relationships were less frequently mentioned. Despite this, these areas were meaningful to some participants.

In conclusion, this study indicates that mindfulness can be a valuable tool for improving emotional well-being and regulation in children and adolescents with ACH and their parents. Moreover, the results suggest that this intervention could also be effective for other populations with similar conditions. Further research with larger samples and designs combining online and face-to-face sessions is recommended to confirm

and expand upon these findings.

Funding

The authors did not receive support from any organization for the submitted work.

CRediT authorship contribution statement

Àngel Casellas: Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Project administration, Methodology, Investigation, Formal analysis, Conceptualization. **Anna Casellas-Grau:** Writing – review & editing, Validation, Software, Methodology, Data curation, Conceptualization. **Àngel Serra:** Validation, Resources, Methodology, Conceptualization. **Ester Busquets-Alibés:** Writing – review & editing, Validation, Supervision, Resources, Project administration, Methodology, Conceptualization.

Participants and informed consent

Informed consent was obtained from all participants before their inclusion in the study. For minors, consent was provided by their parents, in accordance with ethical guidelines. The consent process ensured participants were fully informed about the study's purpose, procedures, and potential risks. Confidentiality was maintained throughout the study, and participants were made aware of their right to withdraw from the study at any time without any consequences.

Disclosure of potential conflicts of interest

The authors declare they have no conflicts of interest.

Data availability

Data will be made available on request.

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