Online multidisciplinary interventions for paediatric chronic pain: a content analysis

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**Significance:** This content analysis of online interventions for paediatric chronic pain highlights the need for multidisciplinary practices in pain management to be translated into online interventions. Improving the availability of pain management resources is essential for many families who cannot attend specialist pain clinics, particularly in the context of the COVID-19 pandemic. There is potential for new resources, as well as for established resources, to be further developed to deliver a broader range of pain management content.

Online multidisciplinary interventions for paediatric chronic pain: a content analysis

Paediatric chronic pain is prevalent (King et al., 2011; Gobina et al., 2019). As understanding of chronic pain has shifted to a biopsychosocial model, the recommended assessment and management approach is multidisciplinary, with equal focus on biological, psychological and social factors (Liossi & Howard, 2016; World Health Organization, 2020). Intensive interdisciplinary treatment, where clinicians from multiple disciplines work collaboratively towards the same biopsychosocial treatment goals (IASP, 2018), can significantly improve functional disability (Harrison et al., 2019). Indeed, multidisciplinary treatment for chronic pain is aims to improve the quality of life of children and adolescents by attending to all aspects of their development and wellbeing (World Health Organization, 2020). Many multidisciplinary interventions have been developed and evaluated. However, multidisciplinary components within online interventions have not been examined.

Systematic reviews have investigated face-to-face interventions for paediatric chronic pain combining at least two (Liossi et al., 2019) or three disciplines (Hechler et al., 2015). Randomised controlled trials (RCTs) of intensive interventions including three or more disciplines found large improvements in pain intensity, and disability, at 3-month follow-up (Hechler et al., 2015). Interventions including two or more disciplines showed significant improvements pre to post-intervention for pain intensity and functional disability (Liossi et al., 2019). Despite benefits of face-to-face interventions, there are barriers to attending pain services for children and parents, including school absence and financial costs of travel (Bender et al., 2011; Caes et al., 2018). One solution is to provide online interventions.

The efficacy of online psychological approaches to paediatric chronic pain management has been investigated (Fisher et al., 2019). This systematic review found 10 studies, which were split into mixed chronic pain and headache. No beneficial effects were found post-treatment for mixed pain and there was a lack of follow-up data. For headache, there was a significant reduction in headache severity at post-treatment only. Authors highlighted findings were likely due to low quality evidence (Fisher et al., 2019). Another systematic review of the availability of ‘e-health tools’ for paediatric pain, including pain assessment tools and online/ digital pain management interventions (Higgins et al., 2018) identified 53 tools, including 26 tools for chronic pain. Thirteen tools out of 53 were available to patients, with barriers including time and funding. Despite this, a survey of adolescents and parents indicated that new, accessible online pain management interventions would be welcomed (Hurley-Wallace et al., 2020).

Internet use has rapidly increased over the past several years, especially since the introduction of smartphones in 2009/ 2010 (Ofcom, 2017). Recent statistics indicate that 93% of 8- to -11-year-olds go online for more than 13-hours a week, and 99% of 12- to-15-year-olds for more than 20-hours (Ofcom, 2019). Expert opinion recently highlighted the expansion of digital healthcare in paediatric chronic pain, with emerging interest in mobile health (Richardson et al., 2020). Therefore, it is important that available online resources for paediatric chronic pain reflect evidence-based pain management practices, with the aim to encompass current best practice recommendations for multidisciplinary chronic pain management in children (World Health Organization, 2020). The current study evaluates which existing interventions reflect multidisciplinary chronic pain management strategies, with a focus on individual multidisciplinary components, which has not previously been investigated. Recommendations for the improvement and expansion of online pain management interventions are provided based on the findings of the current study. Such recommendations are timely given the context of the COVID-19 pandemic, where online resources have become integral to chronic pain management (Eccleston et al., 2020).

This study aimed to 1) identify which multidisciplinary chronic pain management strategies are reflected within the content of existing online multidisciplinary interventions for paediatric chronic pain management, 2) map the content of existing online interventions for paediatric chronic pain to evidence-based clinical guidelines for multidisciplinary pain management, and evaluate how well each chronic pain management strategy is addressed by the identified interventions, 3) summarise and evaluate the development approaches used by the identified interventions, and provide practical recommendations for current and future intervention development teams.

Methods

# Search strategy

A previous systematic review of e-health tools for paediatric pain (Higgins et al., 2018) was updated for the period 3rd May 2017 to 1st April 2020, using the same search terms and databases (tableS5). Additional inclusion and exclusion criteria were added in-line with the aims of the current study. The systematic review by Higgins et al. (2018) reviewed e-health tools for paediatric pain assessment and/or management and paired this with a survey completed by the authors of the identified tools, regarding the availability of each tool. As the current study investigated pain management interventions only, the inclusion and exclusion criteria were adjusted accordingly to exclude pain assessment tools. The previous review chose to use a 10-year timeline, given rapid changes in technology outlined above. Hence, the current study updated the search from the time-point selected by the previous review, in-line with this rationale.

# Inclusion and exclusion criteria

Inclusion criteria were: 1) the article described an empirical study, written in English and published from 1st January 2007 to 1st April 2020, 2) the article described the development of an online intervention for paediatric chronic pain management\*, and/ or evaluated its use in the target population, 3) the intervention was studied in children and adolescents aged 0-18 years (sample median age less than 19 years), or their parents/ caregivers, 4) interventions were intended for the management of chronic pain lasting three months or longer, 5) interventions either contained content from two or more disciplines or contained multi-component CBT.

Exclusion criteria were: 1) interventions were intended for pain assessment, 2) interventions were intended for the management of acute pain only, 3) interventions were targeted for use by adults, aged 19 years or over, that were not parents/ guardians of children with chronic pain, 4) interventions did not have set content (e.g., peer support platforms).

\*A chronic pain management intervention was defined as any form of intervention which targeted a chronic pain condition, as listed in the ICD-11 (Treede et al., 2019; Treede et al., 2015), with the aim to reduce pain intensity or improve pain-related functional disability.

# Accessibility

All authors/ intervention owners of identified interventions were contacted via email to request access to the intervention online on 25 March 2019. Authors were sent an additional reminder 2-weeks later, on 8 April 2019. Where access was not provided to online content, intervention content was evaluated based on descriptions from available published works.

# Quality Assessment

Interventions were assessed for descriptive report and evaluation quality using the Criteria for Reporting the Development and Evaluation of Complex Interventions in healthcare, revised (CReDECI2) (Möhler et al., 2015). The CReDECI2 contains 13-items pertaining to the quality of reporting for development (4-items), feasibility (1-item), and evaluation (8-items) stages of the research, with reference to any published article that has described, developed or evaluated the intervention in question. The checklist is completed by adding a reference example next to each item, indicating the publication(s) and/ or page number(s) where an example of each criteria can be found. The full checklist of items is provided in tableS3.

# Content analysis: development of target strategies

The target chronic pain management strategies used in the content analysis were developed by the research team, drawing from the treatment guidelines for paediatric pain management in the UK, as outlined by the Royal College of Paediatrics and Child Health (RCPCH, 2018)and guided by clinical expertise from two paediatric pain psychologists in the research team (CL and EN). The RCPCH course is one of only two resources that adopts a biopsychosocial approach to chronic pain management and is freely available to professionals (Hurley-Wallace et al., 2018). A biopsychosocial approach to the management of chronic pain in children is the recommended best practice. Any combination of physical, psychological, or pharmacological interventions should be tailored to the individual child and their family, rather than to the pain type (World Health Organization, 2020). The selected guideline from the RCPCH is a clinician-directed e-learning course entitled ‘Pain Management’ (<https://rcpch.learningpool.com>). The alternative resource is the Canadian online paediatric pain curriculum (SickKids, 2019), which includes similar topics, with the addition of pain in paediatric palliative care and ethical considerations for children with pain (<https://www.sickkids.ca/en/care-services/centres/pain-centre/#oppc>).

The RCPCH course is selected to guide the target strategies for this content analysis as it covers a wider range of specific psychological and physical therapies and has a stronger focus on chronic pain, compared to the Canadian resource. In the RCPCH course, chronic pain management strategies are outlined broadly under ‘psychological and physical therapies’ (Liossi et al., 2015), and ‘pharmacology and prescribing’ (Zarnegar et al., 2015) in modules four and five of the ‘Pain Management’ course, respectively. A full breakdown of the course modules is outlined in Box 1 of the report by Hurley-Wallace et al. (2018).

An advantage of drawing from the RCPCH course is that analyses can be used to investigate whether evidence-based chronic pain management strategies, outlined in clinician-directed courses, are mirrored in online patient-directed interventions. This represents an assessment of knowledge translation from research to practice (Scott et al., 2012), as the clinician-directed course is based on research evidence and established theoretical frameworks in paediatric chronic pain management.

# Target chronic pain management strategies

Interventions were coded for nine target chronic pain management strategies, as follows:

1. Pain education, including psycho-education
2. Goal-setting, including SMART (specific, measurable, achievable, realistic, and timed) goals
3. Sleep hygiene (or sleep routine)
4. School support
5. Multi-component CBT
6. Activity pacing, including e-diaries and symptom tracking
7. Physiotherapy
8. Non-pharmacological physical therapies e.g., massage, desensitisation, TENS (transcutaneous electrical nerve stimulation), thermal analgesia
9. Medications (evidence-based pharmacological advice or advice from clinician)

# Analytic approach

The current study utilised a similar approach to a recent content analysis of pain neuroscience education on YouTube (Heathcote et al., 2019). In this study, each chronic pain management strategy was evaluated for each intervention. To evaluate how well each pain management strategy was represented, content codes were assigned ordinal ratings (0 = ‘no, this strategy is absent’, 1 = ‘yes, this strategy is vaguely represented’, 2= ‘yes, this strategy is clearly represented’). Coding was performed by two separate individuals, using a spreadsheet (Microsoft Excel), which was pre-piloted by the research team. The two coders included one PhD student specialising in chronic pain research (AHW) and one clinical psychologist specialising in paediatric chronic pain management (EN).

There was a possibility for a total of 117 matched codes for all nine chronic pain management strategies across 13 interventions. Raw scores from the coders resulted in 107 matched codes; a high level of agreement was present between the two raters (К = 0.86). As the level of agreement was high, all discrepancies (n = 10) were discussed between the two coders to reach 100% consensus. This data was then analysed by i) providing a descriptive summary of all the final agreed codes as an overview of representation across the dataset, and ii) graphically presenting the number of interventions that addressed each strategy ‘clearly’.

Results

# Included studies

Ninety records cited by the previous review of e-health tools (Higgins et al., 2018) were screened for inclusion/ exclusion by AHW. From the previous review, 26 articles were included in the current study. 666 new records were identified through electronic database searching, covering the review update period 3rd May 2017 to 1st April 2020, and by hand-searching reference lists of records identified through database searching. New records were screened for inclusion/ exclusion by AHW and full-texts were then assessed for eligibility by AHW and DS. Nine new articles were identified in the review update, resulting in a total of 35 included articles, relating to 13 unique interventions.

All included articles are summarised within the evaluation of intervention development approaches and efficacy (tableS2). Only one new intervention was identified (Cunningham et al., 2018), where 12 out of 13 interventions were identified in the previous version of the review. A PRISMA flow diagram of the updated review is provided in Fig 1 (Stovold et al., 2014).

[INSERT FIGURE 1.]

# Summary of identified interventions

Thirteen unique interventions met the eligibility criteria for this content analysis. The content of each of the interventions, including the number of modules, the structure of the intervention, overall duration, appearance, and mode of delivery, including human support offered (if any) is outlined in tableS1. The primary study reference for the intervention description and hyperlink to the study is also included, where available.

Four of the interventions found were developed in the United States (Palermo et al., 2016; Cunningham et al., 2018; Donovan et al., 2013; McCormick et al., 2010). Two interventions were from Canada (Stinson et al., 2010b; Stinson et al., 2014). Two were from Sweden (Lalouni et al., 2017; Flink et al., 2016), and two were from The Netherlands (Voerman et al., 2015; Armbrust et al., 2015). The remaining interventions were developed in Spain (Nieto et al., 2015), Germany (Trautmann & Kröner-Herwig, 2010), and Taiwan (Yeh et al., 2013).

A variety of chronic pain conditions were addressed in these interventions; mixed chronic pain was addressed by four interventions (Voerman et al., 2015; Flink et al., 2016; Stinson et al., 2014; Palermo et al., 2016). One intervention was aimed at recurrent headache (Trautmann & Kröner-Herwig, 2010), and one at migraines (Donovan et al., 2013). Two interventions focused on juvenile idiopathic arthritis (JIA) (Stinson et al., 2010b; Armbrust et al., 2015). Two interventions addressed functional abdominal pain (Cunningham et al., 2018; Nieto et al., 2015), one targeted pain associated with gastrointestinal disorders (Lalouni et al., 2017), one intervention looked specifically at irritable bowel disease (McCormick et al., 2010), and one intervention was aimed at dysmenorrhea (Yeh et al., 2013).

## Accessibility

Eight authors (62%) responded to the request for access; online access was granted by four authors, and additional transcripts and information were provided by two of these authors. Two authors advised that the best description of the intervention in English was provided in the article already found, and one author could not allow access outside of the research team. One author responded advising that the website had been decommissioned. Two authors were uncontactable (email address not recognised) and the remaining three authors did not respond.

## Quality assessment

CReDECI2 checklists for all interventions that were included in the content analysis are available (tableS3), and a colour scale visualisation is provided (tableS4). Overall, the assessments of reporting quality indicated that 11 out of 13 (85%) of the interventions had been evaluated in either a pilot or large-scale RCT (tableS2). Though almost every article mentioned that online interventions can be cost-effective, only one intervention (no specific name) (Lalouni et al., 2017) presented a breakdown of financial costs for personnel, materials, or other development costs. This intervention, which targeted different types of abdominal pain, was evaluated for cost-effectiveness using healthcare cost estimates in US dollars within two separate trials (Sampaio et al., 2019; Lalouni et al., 2019). Only one intervention underwent a process evaluation (Murray et al., 2019) according to available published works, though many captured usability data.

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# Intervention development and evaluations of efficacy

Details of the development process for each intervention, including the development approach and theoretical frameworks used, any professional input, development team details, and details of user-feedback are outlined in tableS2. This table includes 35 studies that report on the development or evaluate the efficacy of the 13 included interventions.

## Theoretical frameworks

Most if the interventions included in the content analysis did not reference theoretical frameworks explicitly; however, many did include components pertaining to well-known frameworks. Eleven (85%) of the identified interventions used multimodal CBT, including elements of mindfulness (tableS2). The internet intervention for functional gastrointestinal disorders (Bonnert et al., 2014; Bonnert et al., 2016; Lalouni et al., 2017), used CBT and mindfulness, with the addition of exposure-based therapy techniques, and behavioural analysis using an Antecedent-Behaviour-Consequence model, which was specific to the intervention (see Bonnert et al., 2014). The Health Promotion Model (Srof & Velsor-Friedrich, 2006), stemming from Social Cognitive Theory (Bandura, 1977), were referenced to support the use of CBT within the Rheumates@Work intervention (Lelieveld et al., 2010; Armbrust et al., 2015). Notably, iCanCope™ was the only intervention that presented a ‘theoretical rationale’ section distinctly in published works (Stinson et al., 2014). Both iCanCope™ and Web-MAP referenced CBT in combination with Social Learning Theory, which can be theoretically related to children’s pain behaviours as a result of parent behavioural modelling (Palermo et al., 2014; Palermo et al., 2016; Stinson et al., 2014). Web-MAP also mentioned integration of Family Systems Theory from the second iteration (Web-MAP2), which a well-known theory that can be used to explain pain-focused family patterns of behaviour (Lewandowski et al., 2007).

## Development approaches

Only one intervention referenced an established development approach (O’Cathain et al., 2019); this was the user-centred design approach, outlined in the development study for iCanCope with Pain™ (Stinson et al., 2014). This intervention was developed with input from focus groups with adolescents and health care professionals, followed by individual interviews with adolescents. Within the same research group, ‘Teens Taking Charge’ adopted an iterative qualitative approach to development by using a mixture of individual interviews (Stinson et al., 2008) and think-aloud interviews with adolescents in separate studies (Stinson et al., 2010a). However, no specific approach was referenced for ‘Teens Taking Charge’.

## Evaluations of efficacy

The current study focuses on evaluating the content of online interventions for paediatric chronic pain, and the development approaches used. Meta-analytic reviews of the efficacy of psychological approaches to online paediatric chronic pain management (Fisher et al., 2019), and in-person interdisciplinary interventions (Hechler et al., 2015; Liossi et al., 2019) have been published elsewhere. Efficacy evaluations, however, remain an important part of developing complex health interventions (final stage of development), according to Medical Research Council (MRC) guidance (O'Cathain et al., 2019). A summary of evaluation studies for the two most rigorously trialled interventions identified in the current study is included below.

The intervention which has undergone the most rigorous testing in terms of randomised controlled trials (RCTs) is Web-MAP2, which is a multimodal CBT-based online intervention. The earliest RCT evaluated the first iteration of the intervention (Web-MAP) (Palermo et al., 2009). The latest iteration, Web-MAP2, was first mentioned in published work referencing an ongoing multicentre RCT (Palermo et al., 2015). The multicentre RCT of Web-MAP2 used a parallel-groups design, in which one group received the Web-MAP2 intervention, and the other received internet-delivered education (Palermo et al., 2016). Findings from 273 adolescents aged 11 to 17 years produced a number of beneficial effects, including a significantly improved functional disability from baseline to 6-month follow-up for the Web-MAP2 treatment group, comparatively to internet education. There were also significant improvements in sleep outcomes, and significant reductions in parent miscarried and parental protective behaviours for the Web-MAP2 group. Overall findings indicated a high level of efficacy. Several secondary analyses of the data from the main Web-MAP2 trial have been conducted (Law et al., 2018; Murray et al., 2019; Chen et al., 2019).

Teens Taking Charge, an online intervention for managing JIA, has also undergone rigorous trialling. An initial pilot RCT of ‘Teens Taking Charge’ found significantly better post-treatment outcomes in the experimental group, who received an internet-based intervention for JIA (Stinson et al., 2010b). The experimental group had a lower average weekly pain intensity, however there were no significant differences between-groups for functional disability, self-efficacy, adherence or stress in the internet intervention group compared to the control group, who had received a telephone-delivered attention control intervention. This intervention has since been evaluated in a multisite RCT, comparing the self-management program with an online education-only program over 12-weeks (Connelly et al., 2019). The main outcomes for the study were pain intensity, pain interference and functional disability, and outcomes were also assessed at 6-month and 12-month follow-up. Participants in both groups showed small, yet significant improvement in the main outcomes, with no significant between-group differences. Predictors of pain and functioning were also analysed, finding that self-efficacy, disease knowledge, anxiety and depression were significant predictors for both groups.

Other trials include iCanCope with Pain™, which targets mixed CP, and has been tested in a parallel groups RCT. Only the mobile symptom-tracking app was investigated (Lalloo et al., 2019), finding that pain-related variables were stable over time (55 days) and adherence to symptom-tracking was moderate-high. The ‘Move It Now’ self-management intervention for adolescents with mixed CP (Voerman et al., 2015) found pain intensity, general behaviour, mental health, family activities all significantly improved during the intervention; this investigation was intended to be an RCT however the design was altered to within-participants due to high attrition rates. The only study included in the content analysis that investigated dysmenorrhea undertook a NRCT to investigate the effectiveness of auricular acupressure combined with internet interactive instruction (Yeh et al., 2013). This study found that the internet intervention with auricular acupressure was significantly better at improving pain and menstrual distress post-intervention compared to acupressure alone.

Content Analysis

A compilation of all the content codes is presented in Fig. 2. Final agreed scores from the two coders are available in Fig. 4. Across all the interventions and chronic pain management strategies, 47% of the agreed codes were ‘yes, clearly represented’, 13% of the codes were ‘yes, vaguely represented’, and 40% were ‘no, absent’ (Fig. 2). The only chronic pain management strategy that was represented (‘clearly’ or ‘vaguely’) by all of the interventions was pain education or psycho-education. The chronic pain management strategy that was the least well represented across the interventions was physiotherapy, which was only referenced in two interventions, followed by non-pharmacological physical therapies, which was referenced in three interventions.

Fig. 3 displays the number of interventions that achieved the highest possible score for each chronic pain management strategy. In these cases, an agreement was reached between the two coders that the target chronic pain management strategy was ‘clearly’ represented. The most ‘clearly’ addressed strategies were pain education and CBT; there were no codes for ‘vaguely’ for CBT. Physiotherapy, non-pharmacological physical therapies, and medications were the least ‘clearly’ represented. Medications were coded as ‘vaguely’ represented most frequently (five out of 13).

[INSERT FIGURE 2.]

[INSERT FIGURE 3.]

All codes for all included interventions are displayed in Fig. 4; all of the interventions addressed at least two chronic pain management strategies clearly. One intervention clearly represented all nine strategies; this was ‘Teens Taking Charge’ for adolescents with JIA (Stinson et al., 2010b). The majority of interventions (69%) represented between four and five strategies clearly in their content. The interventions that addressed five strategies clearly were Web-MAP (Palermo et al., 2016; Palermo et al., 2009), iCanCope™(Stinson et al., 2014), the website for adolescents with migraine (Donovan et al., 2013), and Rheumates@Work (Armbrust et al., 2015; Lelieveld et al., 2010).

[INSERT FIGURE 4.]

Discussion

The current review and content analysis found 13 online interventions for paediatric chronic pain management, with 36 studies relating to development and trialling of these interventions. The content analysis indicated that whilst many online paediatric chronic pain interventions included content from several disciplines, there were few that encompassed a complete multidisciplinary approach (IASP, 2018; World Health Organization, 2020) to paediatric chronic pain management. There was limited translation from evidence-based clinical guidelines (RCPCH, 2018) to online chronic pain management interventions. Specifically, there was a lack of physiotherapy content within interventions reviewed, as well as non-pharmacological physical therapies. There was also a lack of content on sleep hygiene, and medications were vaguely addressed.

Chronic pain management strategies that were the most commonly represented by identified interventions were pain education and multi-modal CBT, where all interventions included pain education, and 12 out of 13 included elements of CBT. Of the interventions that were labelled as CBT-based, including Web-MAP (Palermo et al., 2009; Palermo et al., 2016) and the unnamed internet intervention for abdominal pain (Lalouni et al., 2017), several of the other multidisciplinary strategies were also covered, such as school support and goal setting (Fig. 4). Hence, in terms of encompassing a biopsychosocial approach in online interventions for chronic pain, established CBT-based interventions may serve as a good base from which to expand on content to include medication and physical therapies, if appropriate. There was a significant proportion of abdominal and gastrointestinal-related pain interventions (31%), including the most recently developed intervention (Cunningham et al., 2018); this is likely a reflection of high prevalence of paediatric functional abdominal pain, where meta-analyses have estimated a global pooled prevalence of 13.5% (Korterink et al., 2015). Whilst tailoring to a pain condition may be useful in some contexts, current best practice guidelines recommend a biopsychosocial, multidisciplinary approach to paediatric chronic pain management in general (World Health Organization, 2020). An example of tailoring to a specific pain condition whilst also embodying a multidisciplinary approach is provided by ‘Teens Taking Charge’ (Connelly et al., 2019; Stinson et al., 2010a). This intervention encompassed all target chronic pain management strategies, as defined by the current study, and was specific to JIA (<https://teens.aboutkidshealth.ca/jiateenhub>).

It may be beneficial for intervention development teams to consider whether online interventions that target a specific pain condition or focus on a specific technique (such as CBT) could be extended to incorporate a broader range of content on physical, psychological, and pharmacological components of pain management. This may be a cost-effective way to further develop online interventions such that they can be applied across a broader range of chronic pain conditions, rather than developing new interventions for specific conditions from scratch. An example of this is Web-MAP, which has been trialled for mixed chronic pain and headache (Palermo et al., 2016; Law et al., 2015). Further, online multidisciplinary interventions for chronic pain may be especially useful in adolescent populations, as the current adolescent generation are native internet users, with 99% of 12- to 15-year-olds accessing online content for more than 20-hours a week (Ofcom, 2019).

The rapid development of evidence-based online interventions is warranted in the context of the COVID-19 pandemic, which has resulted in further reduced access to specialist pain services in-person. Though many existing services have recently introduced online clinics, online interventions have the potential to support clinics as complementary resources by creating more flexible pain management plans and encouraging self-management (Eccleston et al., 2020). There has also been suggestion that the prevalence of chronic pain may increase as a consequence of the COVID-19 pandemic (Clauw et al., 2020), hence improving the availability of multidisciplinary interventions may become very important. However, the extent to which multidisciplinary pain management can be delivered online is highly dependent on patient needs. Online self-management of chronic pain should only be recommended to paediatric patients following assessment by a multidisciplinary team (Liossi & Howard, 2016), and formulation of a treatment plan that includes online intervention in an appropriate way. Parts of clinical assessment can be conducted remotely, as has been done throughout the COVID-19 pandemic (Eccleston et al., 2020). Additionally, there are treatment components that cannot be feasibly delivered online, such as tailored physiotherapy, and this may explain the finding of a lack of physiotherapy content in the current review. Although, as shown by ‘Teens Taking Charge’ (Connelly et al., 2019; Stinson et al., 2010a), high quality video examples of basic physiotherapy exercises can be included in online interventions.

Three interventions identified in the current study included peer support in the form of online groups or message boards (Yeh et al., 2013; Donovan et al., 2013; Stinson et al., 2014). Though peer support is not a treatment, it is a critical element of the social domain of the biopsychosocial approach (Liossi & Howard, 2016), and youth with chronic pain often struggle to form strong friendships (Forgeron et al., 2011). There is potential for encouraging peer support through use of online interventions, especially for adolescents, for whom social media is a core part of their daily lives (Ofcom, 2019). Recent research investigating the internet needs of adolescents with chronic pain and their parents has also highlighted social media as a resource that adolescents use to help with pain management (Hurley-Wallace et al., 2020). The exact pattern of usage of popular social media platforms, such as Instagram, and how it relates to pain management in this population is unknown, though warrants investigation in future research. One peer support platform that has been developed in an academic setting and applied successfully in adolescent chronic pain is iPeer2Peer, which was originally developed for JIA (Ahola Kohut et al., 2016; Stinson et al., 2016). The programme provides training for ‘peer mentors’ (16 to 25-year-olds) on a variety of topics, then mentors connect with adolescents using Skype calls.

Eight out of 13 interventions contained parent-facing content, which either directly mirrored or complimented the child or adolescent-facing content (tableS1). Theoretical models, such as the Interpersonal Fear-Avoidance Model (Simons & Kaczynski, 2012; Goubert & Simons, 2014), and research (Palermo et al., 2007; Simons et al., 2008; Logan et al., 2012; Palermo et al., 2014) have emphasised that parental factors play an important role in paediatric chronic pain maintenance. In relation to Web-MAP2 (Palermo et al., 2016), the effects of adolescent-parent agreement of treatment goals has been investigated (Fisher et al., 2017). Whilst participating in the Web-MAP2 intervention, 122 adolescent-parent pairs were asked to select two treatment goals. Pairs that chose the same goals had reduced pain intensity post-treatment, which was maintained at follow-up. The strongest effect of goal agreement on pain intensity was found for physical activity goals (Fisher et al., 2017). The success of incorporating of parent-facing modules in terms of improving treatment outcomes is likely to depend on the individual case of chronic pain. Current best practice for the management of chronic pain in children states that treatment should be child and family-centred (World Health Organization, 2020). However, whether parent-facing content is included may also depend on the target age range for the online intervention, as adolescents aged 15-years and up do not seem to benefit as much from this type of intervention (Murray et al., 2019). There is also the option of providing the online intervention to the child or adolescent with adjunctive in-person parent or family-based therapy, though little guidance exists on how to adapt interventions for paediatric chronic pain to be developmentally appropriate (Palermo et al., 2014).

One of the interventions identified in the current study, ‘Teens Taking Charge’, contained a ‘looking forward’ component, consisting of guidance on vocational prospects for young people, as well as information about transitioning into adult healthcare (Stinson et al., 2010b; Stinson et al., 2010a). Similarly, the iCanCope™ design included a section on ‘transition readiness’. Transition from paediatric to adult care can be challenging for young people; research on JIA indicates that the perceived quality of healthcare during transitional stage is low (Shaw et al., 2007), and that an ideal programme would address psychosocial and educational/vocational needs (Shaw et al., 2004). From a developmental perspective, adolescents with chronic pain may struggle with vocational prospects as a result of poor school functioning, however more research on specific health systems factors that impact chronic pain treatment in older adolescents is needed (Rosenbloom et al., 2017). Research has identified a trend between paediatric chronic pain and psychiatric disorder lifetime prevalence (Campo et al., 2001). Cohort studies have also found that chronic pain and fatigue severity predicts impaired social functioning in adulthood (Westendorp et al., 2016). Part of the solution to this issue could be to bridge the paediatric-to-adult healthcare transition by providing continuation of multidisciplinary pain management to older adolescents online.

Overall, underpinning well-established theoretical frameworks were integrated in the majority of interventions reviewed, though many of the development papers did not explicitly reference these. Theoretical frameworks can be important in the implementation of evidence into practice as outlined by the Theoretical Domains Framework (French et al., 2012). However, basing intervention content on an underlying theoretical framework does not necessarily result in improved intervention effectiveness, as shown by a review of reviews (Dalgetty et al., 2019). In accordance with the MRC guidance (O'Cathain et al., 2019), it is recommended that stakeholder feedback is incorporated into the intervention development process. This can be done by supplementing development frameworks such as the Person-Based Approach (Yardley et al., 2015) (PBA). The PBA seeks to integrate stakeholder insights from intervention design through to evaluation. The development teams from iCanCope with Pain™ (Stinson et al., 2014) and ‘Teens Taking Charge’ (Stinson et al., 2010b) incorporated user feedback. However, there was a lack of specification of the development approaches being used, with only iCanCope stating ‘user-centred’. New guidance on reporting intervention development studies has been released and can be used as a reference point for development teams (Duncan et al., 2020).

Considering the efficacy trials of the interventions included in the current study (tableS2) in relation to the content analysis of interventions, none of the interventions underwent a formal process evaluation, as revealed by the quality assessment (tableS3). Process evaluations are an evaluation of the intervention implementation process (Möhler et al., 2015) and seek to examine the impact of specific intervention mechanisms and contexts on participant outcomes, with an aim to gain insight into what parts of the intervention are effective, for whom and under what conditions (Craig et al., 2008; Bonell et al., 2012). Only one included intervention carried out any form of process evaluation (Murray et al., 2019; Palermo et al., 2009), though this was an evaluation of contextual factors rather than intervention mechanisms .Consequentially, it was not possible to evaluate which content components relate to improvements in which outcomes, such as pain severity and functioning (Craig et al., 2008; Bonell et al., 2012). The secondary analysis of RCT data from Web-MAP2 explored who benefitted from treatment at 12-month follow-up (Murray et al., 2019). An important finding was that pain-related disability improved over time for adolescents aged 11-14 years, compared to adolescents aged 15 -17 years, for whom there was no significant benefit of the intervention compared to the control group. Such findings emphasise the importance of complimenting RCTs with process evaluation, especially where no additional benefit of treatment was found (Law et al., 2015; Trautmann & Kröner-Herwig, 2010; Connelly et al., 2019). Further guidance on conducting process evaluations of complex interventions is provided by the MRC (Moore et al., 2015). For data analysis, a key recommendation includes integrating process data (for example, data about usage or context) into outcomes datasets, to explore whether effects differ by contextual moderators, and test hypothesised mediators. Pre-planning of how process data will be collected alongside outcome data in evaluation studies of online interventions is recommended.

Several limitations can be noted. Firstly, only studies published in the English language were included. This analysis does not include interventions that are only reported in non-English publications, which could vary in content due to cultural differences in approaches to chronic pain management (Perry et al., 2019). Secondly, as the current review is an update of an existing review which followed the same methodology, a protocol of the current review was not registered prior to commencement. Lastly, only four interventions were accessible online, therefore it is likely that that evaluations of content were more accurate for these interventions, compared to those that were evaluated using published descriptions.

# Conclusions

Multidisciplinary content included in existing online interventions for paediatric chronic pain management was evaluated with reference to evidence-based guidelines. The content analysis revealed a lack of online interventions which cover all aspects of multidisciplinary pain management. There is scope for existing online interventions that focus on a specific pain condition, or technique (such as CBT), to be further developed to include a broader range of content. Further development of existing online interventions is warranted in the context of the COVID-19 pandemic, to ensure multidisciplinary pain management content can be accessed from home. It is equally important that new interventions being produced are evidence-based and reflect current best practice guidelines. New interventions should aim to incorporate insights from children and adolescents with chronic pain, and their families, using a robust development approach. Pre-planning of process evaluation is recommended to allow investigation of which intervention components are effective for which users and in which contexts.

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Figure 1. PRISMA flow diagram of the updated systematic review.

Figure 2. Percentage of final codes for all target chronic pain management strategies.

Figure 3. Number of interventions that ‘clearly’ represented each chronic pain management strategy.

Figure 4. Colour scale table displaying which chronic pain management strategies were ‘clearly’ or ‘vaguely’ represented, or ‘absent’, for each intervention.