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Can internet-delivered pain management programs reduce psychological distress in chronic pain? Exploring relationships between anxiety and depression, pain intensity, and disability.

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Abstract

Adults with chronic pain who also report high pain intensity and disability are more likely to experience depression and anxiety symptoms. The current study examined changes in anxiety and depression symptoms after an internet-delivered pain management program based on baseline pain intensity and disability severity categories. In a secondary analysis of data from four randomised controlled trials (n = 1333), greater pain intensity and disability were associated with increased odds of elevated anxiety or depression symptoms at baseline. Treatment led to greater reductions in anxiety and depression symptoms compared to a waitlist control, and these improvements occurred irrespective of baseline pain intensity or disability severity. Those individuals who reported ≥ 30% improvements in pain intensity or disability at post-treatment were more likely to also report ≥ 30% improvements in psychological symptoms. Importantly, most participants who achieved ≥ 30% improvements in depression and anxiety had not experienced such improvements in pain intensity or disability. These findings suggest that emerging internet-delivered pain management programs can lead to reductions in psychological distress even when pain intensity and disability are severe or do not improve with treatment. This indicates the value of such treatments in treating distress and improving mental health in people with chronic pain.

Introduction

Anxiety and depressive symptoms are common in individuals with chronic pain [1–3]. Increased anxiety and depression symptoms can lead to a reduced quality of life and greater disability in people with chronic pain [4–6]. Increases in psychological distress have also been associated with higher pain intensity ratings in people with chronic pain, and mediate the impact of changes in pain intensity on disability outcomes [7–9]. As psychological distress is associated with more intense pain and greater disability, many pain management programs (PMPs) now include psychological components, and focus on reducing the psychological distress and disability associated with chronic pain.

Although reduced pain intensity is a common treatment goal for both health professionals and chronic pain patients [10,11], current treatments only result in small to moderate improvements in pain intensity [12,13]. Not all patients experience clinically meaningful reductions in pain intensity, and some have argued that pain intensity should not be the primary goal of treatment [e.g., 14]. In light of these considerations, the field has shifted towards alternative treatment outcomes, such as reduced disability and psychological distress [15,16]. Psychological pain management programs have been developed to support people to self-manage the psychological distress and disability associated with chronic pain, and draw on skills and strategies from evidence-based psychological therapies (e.g., cognitive behaviour therapy, problem solving therapy, acceptance and commitment therapy). These psychological PMPs result in clinically significant improvements in anxiety, depression, and disability – as well as pain intensity – when delivered face-to-face or online [16,17]. The mechanisms by which these changes occur are unclear, but several important observations have emerged.

There is evidence to suggest that during treatment, improvements in psychological distress and pain-related cognitions (e.g., pain catastrophizing, fear of pain) may occur prior

to improvements in pain intensity or disability in people with chronic pain [12,18]. Indeed, some clinical trials have reported treatment-related improvements in depression without comparable reductions in pain intensity [e.g., 19]. These findings suggest that people with chronic pain can experience treatment-related improvements in their mental health even when other factors, such as pain intensity or disability, do not improve, highlighting the broad value of psychological approaches to pain management. That is, an approach that focuses on teaching people with chronic pain how to manage the impacts of chronic pain on their day-to-day functioning and mental health, rather than reduce the intensity of their pain, which may not be possible for all people with chronic pain. However, one important question is whether psychological approaches to pain management can improve the mental health of people with even the most severe pain and disability. While several studies have examined the associations between mental health symptoms, pain intensity, and disability [7,8,20–22], and the influence of pain severity and disability on the efficacy of face-to-face pain management programs [23–26], few studies have examined these issues in the context of internet or remotely-delivered pain management programs [27]. Given the increasing interest in remotely-delivered PMPs [17], there is a need to examine these issues among people with chronic pain engaging in these emerging form of PMPs.

Using existing data from an internet-delivered PMP, the current study sought to examine whether elevated anxiety or depression symptoms were associated with elevated pain intensity or disability levels. It also sought to examine whether an internet-delivered PMP could produce improvements in anxiety and depression based on two important clinical factors, initial pain intensity and disability levels. Finally, it sought to examine whether clinically meaningful improvements in anxiety and depression were dependent on experiencing improvements in pain intensity and disability. The current study involved three sets of analyses. First, we examined the odds of elevated anxiety and depression symptoms in

adults with chronic pain according to pain intensity and disability severity categories at baseline. Second, we examined treatment-related changes in anxiety and depression symptoms based on baseline pain intensity and disability severity categories. Third, we examined the odds of participants achieving clinically meaningful improvements (i.e., ≥ 30%) [28] in anxiety or depression based on their improvements in pain intensity or disability.

Method

Sample. The participant sample (n = 1333) was derived from previous randomized controlled trials examining the effectiveness of an internet-delivered psychological PMP, the Pain Course [29–32]. Across the four trials, participants were randomly allocated to receive treatment immediately (n = 912) or following a waitlist period (n = 421). The demographics of the sample are shown in **Table 1**.

The following inclusion criteria were used to screen applicants across three of the four trials (n = 1271): 1) experienced pain for at least 6 months, 2) pain had been assessed by a medical professional, 3) Australian resident, 4) at least 18 years of age, 5) had computer and internet access, and 6) not currently experiencing a psychotic illness, severe depression, or suicidal ideation. One trial (n = 62) involved three additional or alternative inclusion criteria: 1) the duration of chronic pain only needed to be 3 months, 2) medication needed to be stable – i.e., longer than one month, and 3) applicants could not be receiving concurrent cognitive behaviour therapy.

Treatment. Participants were randomized to receive either the Pain Course immediately or after an 8-week waiting period. The Pain Course was mostly delivered over the internet, although some participants received the treatment in a workbook format. The Pain Course is based on the principles of cognitive behavior therapy and is designed to improve symptoms of depression, anxiety, and disability. Across an 8-week treatment period,

the Course includes five online lessons, practice exercises, additional resources (e.g., problem solving), and case stories. All participants received regular automatic emails, and were randomized to proceed through the treatment in a self-guided or clinician-guided capacity. Further details regarding the treatment and the impacts of delivery format and clinical guidance can be found in the primary publications [29–32].

Measures. The self-report questionnaires were taken from a larger battery which participants completed online prior to starting treatment (i.e., baseline) and immediately following (i.e., post-treatment). The current study extracted the GAD-2 as a measure of anxiety symptoms and the PHQ-2 as a measure of depressive symptoms [33–35]. The GAD-2 consists of two cognitive/ affective items from the original GAD-7 (*Over the last two weeks, how often have you been bothered by (1) feeling nervous, anxious, or on edge, and (2) not being able to stop or control worrying*). The PHQ-2 consists of two cognitive/ affective items from the original PHQ-9 (*Over the last two weeks, how often have you been bothered by (1) little interest or pleasure in doing things, and (2) feeling down, depressed, or hopeless)*. Total scores on the two scales range from 0 to 6. Prior studies recommend a cut-off score of ≥2 on the PHQ2 and ≥3 on the GAD-2 as indicative of clinical symptoms [2,6,38]. The current study used a conservative cut-off score of ≥ 4 to ensure respondents were experiencing clinically relevant symptoms (i.e., endorsing symptoms most of the time).

Average pain intensity was measured using Item 3 from the Wisconsin Brief Pain Questionnaire (WBPQ) [36], and was categorized as low (0-4), moderate (5-6), or high (7-10) [37]. The Pain Disability Index (PDI) was used to assess pain-specific interference in functioning [38], and was used in two of the four randomized controlled trials – resulting in a sub-sample of n= 800. The PDI was categorized into quartiles based on total scale scores for analysis (0-17, 18-35, 36-53, 54-70).

Statistical Analyses. Zero order correlations were used to examine associations between the primary outcome measures at baseline. To address Aim 1, binary logistic regression analyses examined the odds of clinical anxiety or depressive symptoms (yes/no) using pain intensity and disability (categorical indicators) at baseline. All binary logistic regression analyses were adjusted for age and gender. The odds ratios and 95% confidence intervals are reported. To address Aim 3, binary logistic regression analyses were used to examine the odds of experiencing a ≥ 30% improvement in anxiety and depression (yes/no) based on whether participants had also achieved a ≥ 30% improvement in pain intensity or disability (yes/no). An improvement ≥ 30% has been identified as indicating clinically meaningful improvement in pain intensity and pain-related disability [28,39] and has also been used to capture clinically meaningful improvements in anxiety and depression [27,40].

To address Aim 2, generalized estimating equation models were used to examine change in psychological symptoms over the course of treatment, consistent with best practice for longitudinal clinical trial data [41,42] and previous work by our research group [43]. A gamma with log link response scale and unstructured working correlation matrix were used; log-link transformations were used as the data violated tests of normality at both baseline and post-treatment. Multiple imputation was used to handle missing data at post-treatment [44]. Group, time, and severity category (WBPQ or PDI) were entered as predictors, and the PHQ-2 and GAD-2 were entered as dependent variables. For the purposes of the current study, we report the main effect of severity category (i.e., examining how scores differed between severity categories), group × time interaction (i.e., examining how scores changed across time in treatment versus control), and group × time × severity category interaction (i.e., examining how scores changed across time in treatment versus control according to severity category). Within-group percentage change (with 95% confidence intervals) and between-groups Cohen's d (with 95% confidence intervals) are reported.

Results

Descriptives

The collated chronic pain sample was mostly female (83%) with an average age of 52 years (SD 14; see **Table 1**). A large proportion of individuals were taking prescription medication for pain management (77%) and had attended a specialist pain clinic (45%). Just under half of the sample (45%) were taking prescription medication for their mental health. The most common chronic pain conditions were muscular pain (62%), followed by fibromyalgia (24%) and osteoarthritis (20%). At the sample level, individuals rated their average pain as 5.80 out of 10 and had experienced chronic pain for over 9 years.

Correlations between the primary outcome measures were conducted at baseline (see **Table 2**). Weak to moderate correlations were observed between depression anxiety, and average pain intensity. The association between the anxiety and average pain intensity became non-significant when controlling for age and gender. Weak to moderate correlations were also observed between measures of psychological distress and disability.

Aim 1: Odds of elevated anxiety and depressive symptoms at baseline

Mean scores on the PHQ-2 (depression) and GAD-2 (anxiety) are presented according to WBPQ (pain intensity) and PDI (disability) scores in **Table 3**. Binary logistic regression analyses examined the odds of elevated symptoms of anxiety or depression based on pain characteristics.

Depression Symptoms (PHQ-2).

Compared to a reference category of a 0-4 pain intensity rating, individuals who reported their average pain as 5 out of 10 or greater were more likely to report elevated depression symptoms (ORs 1.73 – 3.78). The likelihood of elevated symptoms was also greater as self-reported disability increased. Those individuals with scores above 36 on the

PDI were more likely to report heightened depressive symptoms (ORs 11.23 – 25.06) compared to a reference category of PDI scores between 0-17.

Anxiety Symptoms (GAD-2).

Individuals who reported their average pain on the WBPQ as 5 out of 10 or greater were more likely to report elevated anxiety symptoms (ORs 1.64 – 2.58) when compared to a reference category of a 0-4 pain rating. On the PDI, those individuals with scores above 36 were more likely to report heightened anxiety symptoms (ORs 3.03 – 6.77) compared to a reference category of PDI scores between 0-17.

Aim 2: Treatment outcomes according to baseline pain intensity and disability

GEE analyses examined the association of baseline pain characteristics with change in anxiety and depressive symptoms in those who received treatment or a waitlist control. The estimated marginal means are presented in **Table 4** (depression symptoms) and **Table 5** (anxiety symptoms)**.**

Depression Symptoms (PHQ-2).

Pain Intensity (WBPQ). Depression symptoms increased as participants' pain intensity increased (main effect of severity category: $p < .001$). A greater reduction in depression symptoms were reported in treatment versus control participants (group × time interaction; $p < .001$). However, treatment-related change in depression symptoms did not differ according to baseline pain intensity category (group × time × severity category interaction; $p = .24$), indicating participants improved similarly in depression symptoms irrespective of baseline pain intensity.

Disability (PDI). Again, depression symptoms increased as disability levels increased as measured by the PDI (main effect of severity category: $p < .001$). A greater reduction in depression symptoms were reported in treatment versus control participants (group × time

interaction; $p < .001$). However, treatment-related change in depression symptoms did not differ according to baseline disability severity as measured by the PDI (group × time × severity category interaction; $p = .41$), indicating participants improved similarly in depression symptoms irrespective of baseline disability.

Anxiety Symptoms (GAD-2).

Pain Intensity (WBPQ). Anxiety symptoms increased as participants' pain intensity increased (main effect of severity category: $p < .001$). A greater reduction in anxiety symptoms were reported in treatment versus control participants (group × time interaction; $p < .001$). However, treatment-related change in anxiety symptoms did not differ according to baseline pain intensity category (group × time × severity category interaction; $p = .39$), indicating participants improved similarly in anxiety symptoms irrespective of baseline pain intensity.

Disability (PDI). Anxiety symptoms also increased as participants' disability levels increased on the PDI (main effect of severity category: $p < .001$). A greater reduction in anxiety symptoms were reported in treatment versus control participants (group × time interaction*;* $p = .005$). Again, treatment-related change in anxiety symptoms did not differ according to baseline disability severity as measured by the PDI (group × time × severity category interaction*;* $p = .12$), indicating participants improved similarly in anxiety symptoms irrespective of baseline disability level.

Aim 3: Odds of clinically meaningful improvement in anxiety and depression

The proportions of participants making clinically meaningful improvements (defined as ≥ 30% improvement from baseline) [28] in the treatment and control groups are reported in **Table 6**. A greater proportion of participants in the treatment group achieved improvements compared to the control group, and this was evident across all four outcomes. For instance,

57% of treatment participants achieved a ≥ 30% improvement in depression symptoms compared to 21% of control participants.

The odds of experiencing a clinically meaningful improvement in depression and anxiety was examined based on whether participants also achieved a clinically meaningful improvement in pain intensity or disability. As we were interested in treatment-related improvements, these analyses were only conducted for the treatment group.

Depression Symptoms (PHQ-2).

Pain Intensity (WBPQ). The likelihood of clinical improvement in depression symptoms was significantly higher for those participants who made a concurrent improvement in pain intensity (OR 2.37, $p < .001$). Over a third of the treatment sample (39%) made an improvement in depression symptoms without a concurrent improvement in pain intensity; twice the number of participants with improvements in both depression symptoms and pain intensity (18%).

Disability (PDI). Similarly, participants were more likely to make a clinical improvement in depression if they if they also improved in disability as measured by the PDI (OR = 2.56, $p < .001$). Most participants who had experienced a clinically meaningful improvement in depression had not experienced an improvement in disability (33% of total sample).

Anxiety Symptoms (GAD-2).

Pain Intensity (WBPQ). Individuals were approximately twice as likely to make a clinical improvement in anxiety if they had also made a clinical improvement in pain intensity (OR 1.92, $p < .001$). Approximately a third of the treatment sample made clinical improvements in anxiety even when concurrent improvements in pain intensity had not been achieved (34%).

Disability (PDI). Participants were approximately twice as likely to achieve a clinical improvement in anxiety if they had experienced an improvement in disability measured with the PDI (OR = 1.91, $p = .006$). Most of the treatment sample who reported clinically meaningful improvements in anxiety did not report the clinically meaningful improvements in disability (29% of total sample).

Discussion

Using a large sample of individuals with heterogeneous chronic pain conditions, we explored the efficacy of a psychological PMP on psychological distress according to pain intensity and disability severity at baseline. Although greater pain intensity and disability were associated with higher distress prior to treatment, treatment resulted in significant improvements in anxiety and depression irrespective of baseline pain intensity or disability. Those individuals who made clinically meaningful improvements (i.e., ≥ 30% reductions) in pain intensity or disability were significantly more likely to also report improvements in anxiety and depression symptoms. Notably, most participants who reported clinically meaningful improvements in psychological distress had not experienced such improvements in pain intensity or disability. These findings suggest that internet-delivered PMPs can improve psychological distress among people with chronic pain irrespective of pain intensity and disability levels, and can produce clinically meaningful improvements in psychological distress even when improvements in pain intensity or disability are not reported.

The current study found that participants with higher pain intensity ratings were more likely to experience elevated symptoms of anxiety and depression. This is consistent with past work showing that increased pain intensity is associated with greater depressive symptoms and poorer functioning [20–22], and that both pain intensity and pain-related disability predict depressive and anxiety symptoms [45]. The current study also replicated previous reports of strong associations between disability and depressive symptoms in individuals with

chronic pain [7,8,46,47]. Thus, the current study suggests similar patterns of relationships between anxiety, depression, disability and pain intensity are also observed among people using internet-delivered PMPs. Future work may explore whether there is an additive, or interactive, effect of pain intensity and disability, such that those with intense and disabling pain may show higher odds of clinical depressive symptoms than those with intense but minimally disabling pain [48].

The current study extends upon past work by exploring how treatment efficacy may differ when compared across baseline pain intensity and disability categories. Promisingly, depressive and anxiety symptoms improved from pre-treatment to post-treatment regardless of baseline disability or pain intensity, and we did not find any evidence of differences in treatment efficacy based on baseline pain intensity or disability severity. The co-occurrence of clinically meaningful improvements (defined as ≥ 30% improvements) [28] in anxiety and depression, and pain intensity and disability, were also examined. Treatment participants were significantly more likely to report improvements in psychological distress if they had experienced an improvement in pain intensity or disability – however, the majority of participants who experienced reductions in psychological distress had not experienced clinically meaningful improvements disability or pain intensity. This suggests that, although changes in pain intensity and disability are beneficial [25,27,49], they are not necessarily required in order to experience clinically meaningful improvements in psychological distress. It is possible that effective treatment may weaken the associations between pain intensity, disability, and psychological distress, such that patients with chronic pain can experience improvements in their mental health independently of improvements in pain intensity and disability severity.

Across the field, the focus on depression in chronic pain has been greater than that on anxiety, and fewer studies have explored predictors of anxiety symptoms in people with

chronic pain, or how anxiety develops and is maintained in this population [45,50,51]. This may be, at least in part, due to the overlap between symptoms of anxiety and those symptoms captured by the fear-avoidance model of pain, including hypervigilance, catastrophizing, and avoidance [52,53]. Due to this overlap, research may have ignored the potential role of clinical anxiety in exacerbating chronic pain, that is, above and beyond pain-specific anxiety. While there are unavoidable overlaps between the two constructs, it would be worthwhile for future research to explore the incidence of generalized anxiety, as opposed to only pain-specific anxiety, in people with chronic pain. Previous work illustrates the detrimental impact of general anxiety on quality of life in people with chronic pain [54,55], highlighting the importance of anxiety as a treatment target. As greater pain intensity and disability were associated with a greater likelihood of elevated anxiety symptoms, our findings highlight the potential importance of also understanding the development, maintenance, and treatment of general anxiety in individuals with chronic pain.

The current findings support the value of internet-delivered psychological PMPs for chronic pain, and particularly their ability to reduce psychological distress and improve mental health irrespective of pain severity and disability. However, our findings should be acknowledged in light of some limitations. First, the current study relies on data from one specific internet-delivered PMP that has been specifically designed to help people manage both the mental health and functional impacts of chronic pain. Reflecting this, the program covers psychological content such as psychoeducation, cognitive challenging, arousal management, activity scheduling, and relapse management [29–32]. Further replication using different internet-delivered PMPs is needed, as well as future studies utilizing dismantling designs to explore which intervention components drive reductions in psychological distress would be informative. Second, the nature of the associations between pain intensity, disability, and mental health symptoms cannot be determined from the current paper. Indeed,

it remains unclear whether pain intensity and self-reported disability confer risks for the development or maintenance anxiety and depression, vice versa, or both. Moreover, the current study employed self-report measures of anxiety and depression, as is standard in clinical trials of pain treatments [e.g., 19,56]. This required the current study to employ a conservative cut-off score on the self-report measures as an indicator of clinical symptoms as opposed to formal diagnoses obtained through diagnostic interviews. In saying this, the self-report measures used in the current study have been validated for use in chronic pain [57,58], and it is therefore unlikely that the results would differ using formal diagnostic data. Thirdly, the primary trials excluded participants with very severe depression or suicidality, a decision which is likely to have excluded some participants with the most severe and/or disabling pain [59,60]. Thus, replications of our findings without such exclusion criteria are warranted.

The current study examined associations between pain intensity, disability, and psychological distress prior to and following an internet-delivered PMP. Despite being associated with an increased likelihood of psychological distress at baseline, improvements in anxiety and depression were observed irrespective of baseline pain intensity and disability level. Specifically, even those participants with the most intense or disabling chronic pain reported improvements in their mental health symptoms. While adults with chronic pain were more likely to report improved psychological distress if they had also experienced improvements in pain intensity or disability, approximately a third of the sample who received treatment demonstrated improvements anxiety or depression without concurrent improvements in pain intensity or disability. This study supports the ability of internet-delivered PMPs to improve the mental health patients with the highest pain intensity and disability levels, and without necessarily requiring a concurrent improvement in pain intensity or disability. Further replication addressing the limitations of the current study is needed before firm conclusions can be drawn. However, the results of the current study are

encouraging and illustrate the potential of internet-delivered PMPs to address the mental health difficulties associated with chronic pain.

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