An evaluation of a digital pain management programme: clinical effectiveness and cost savings

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Abstract

Introduction: Chronic pain is one of the most prevalent causes of disability worldwide, and digital interventions may be one of the ways to meet this need. Randomised controlled trials have demonstrated that digital interventions can be effective in treating chronic pain. This study aimed to establish the clinical effectiveness of a web-based pain management programme (PMP), specifically whether it would lead to improved clinical outcomes and reduced health care costs in a real-world clinical setting.

Methods: Of 738 participants, 438 engaged with the programme and 300 did not. Two analyses were conducted: a within-subjects pre-post comparison of clinical outcomes for participants who completed the programme and a between-groups comparison of health care usage for those who engaged and those who did not.

Results: Participants who completed the programme made significant improvements with regard to their perceived health status, level of disability, mood, confidence managing pain, problems in life due to pain and level of pain. Around one-third of participants made reliable changes in their levels of disability, depression and anxiety. There was no relationship between gender or age and engagement with the programme. Those who engaged with the programme demonstrated reduced health care costs in the year following referral, whereas health care costs of non-engagers increased. Limitations of the study include a high drop-out rate and a non-randomised comparison group. Results must therefore be interpreted with some caution.

Conclusion: A web-based pain management programme can be clinically effective and may be a useful addition to the treatments offered by pain management services.

Keywords

Chronic pain, digital interventions, psychoeducation, online, pain management programme, cognitive behaviour therapy, web-based, cost saving, clinical effectiveness, evaluation

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Introduction

A systematic review by Fayaz et al.¹ found 'between 10.4% and 14.3% of the population of the UK report severely disabling chronic pain that is either moderately or severely limiting'. The effect of chronic pain on individuals can be all-encompassing and is associated with sleep difficulties, problems conducting social activities, difficulty in walking and driving.² In addition, Rayner et al.³ reported a prevalence of 60.8% of depression in individuals with chronic pain attending a tertiary pain management service, with 33.8% meeting the criteria for severe depression. The economic impact of chronic pain is also significant. Gaskin and Richard⁴ put the national cost of pain in the United States at between US\$560bn and US\$635bn in 2010, which includes the cost of health care and the cost of lost productivity attributable to pain.

Reviews of the research literature indicate that multidisciplinary biopsychosocial pain management programmes (PMPs) are the most clinically and cost-effective approach to address the complex range of problems experienced by individuals with chronic pain.⁵ Cognitive and behavioural treatments designed to ameliorate pain, distress and disability were introduced more than 40 years ago and have become well established.^{6,7} A systematic review of 40 randomised clinical trials concludes that PMPs based on cognitive behavioural therapy (CBT) principles are an effective treatment for chronic pain in adults and have statistically significant but small effects on pain and disability and moderate effects on mood and catastrophising immediately post-treatment.⁸ Morley et al. argue that while randomised controlled trials (RCTs) provide evidence for the efficacy of CBT programmes for chronic pain, they do not necessarily provide evidence of effectiveness, or whether a treatment provides a measurable benefit when delivered to patients in other service contexts.^{9,10} Morley et al.⁹ found evidence of clinically significant gains for patients that attended PMPs, which suggests this treatment is clinically effective. Furthermore, a systematic review of RCTs conducted by Pike et al.¹¹ demonstrated that psychologically based pain management interventions can reduce health care usage and therefore health care costs.

Garg et al.¹² assert that online interventions may be a solution to the limitations of face-to-face CBT, such as low accessibility, higher costs and effort required on the part of patients. With increasing Internet access, the option of administering web-based CBT interventions has become a possibility.^{13,14} Macea et al.¹⁵ argue that online CBT offers several advantages over face-to-face treatment, for example, the treatment can be accessed at any time and place, and material can be reviewed at any point. Furthermore, the anonymity

afforded can remove the barrier of perceived stigma from seeing a therapist.¹⁶ There is a growing body of evidence supporting the efficacy of online cognitive behavioural interventions in treating pain, physical disability, depression and anxiety in individuals with non-headache pain.^{15,17} However, the quality of these early trials is reported to be fairly low.

A recent systematic review conducted by Garg et al.¹² identified nine RCTs of web-based interventions for chronic pain: four were CBT-based, while five were mainly concerned with improving knowledge. They found that the CBT interventions showed promise in terms of reducing catastrophisation and improving patients' attitudes. However, many studies had significant weaknesses, such as small sample sizes, heterogeneous demographics and lack of blinding. Dear et al.¹⁸ found encouraging results in their RCT evaluating an Internet-delivered PMP with different levels of clinician support. All of their groups reported improvements in anxiety, depression and average pain. They concluded that significant clinical outcomes can be obtained through Internet-delivered programmes even with very little or no clinical contact, and that this highlights the potential of Internet-delivered PMPs. However, due to numerous limitations, they advise caution in interpreting the results. A systematic review of digital interventions for lower back pain using different delivery methods was conducted by Nicholl et al.,¹⁹ which included six completed RCTs and three planned RCTs. They concluded that digital intervention studies are poorly described, and that this makes it difficult to determine what works best and for whom it works, and, therefore, further research into the effectiveness of digital interventions is still required to determine factors that may influence outcome.

In sum, there is evidence for the clinical and cost-effectiveness of face-to-face CBT-based PMPs, and the evidence for the efficacy of online CBT-based PMPs for chronic pain is promising. However, there is limited evidence for the clinical or cost-effectiveness of online CBT for chronic pain in routine clinical settings, which is important as RCTs can lack external validity. As Garg et al.¹² discuss, samples in RCTs may be so carefully selected that their external validity becomes questionable. Studies with alternative designs may have greater external validity, enabling assessment of factors relating to the implementation of programmes in real-world settings. For instance, considering whether participants are representative of patients in clinics, whether the programme is implemented consistently across all staff and settings and what drop-out rates are seen in routine clinical settings.²⁰

This evaluation of a web-based PMP, in a routine clinic setting, was undertaken to answer the following questions:

- Does a web-based PMP lead to improved clinical outcomes?
- Do age, gender or duration of pain affect engagement with, or completion of, a web-based PMP?
- Does a web-based PMP reduce health care-related costs?

Methods

Design

The design involved two comparisons: first, a within-subjects pre-post comparison of clinical outcomes for people completing the web-based PMP and, second, a between-groups comparison of health care usage for those who engaged with the web-based PMP and a comparison group who were offered but did not engage with the treatment.

Pathway through Pain

Pathway through Pain (PTP) is a commercially available, digital PMP.²¹ It follows a cognitive behavioural approach including psychoeducation, mindfulness, relaxation and stretching exercises. Participants are required to work through a series of 24 'steps', each comprising a video introduction and a number of interactive activities. Throughout the programme, visual analogue scales are used to collect 'tracker' data at each log-in, and there are interactive questionnaires for participants to complete at set points (see the 'Measures' section). Participants are also able to complete a confidential pain journal online to record their experiences. There is a limit to how many steps participants can complete during one login to ensure that they have time to take in the information received. (See Appendix 1 for further information about the content of the intervention.)

Measures

Demographic data were extracted from the 'Client Information Forms' which people completed as part of the screening process.

Data measuring clinical effectiveness were collected using four standardised, self-report measures which were completed online as a part of the programme at the first login (step 3) and the last login (step 23). Participants' perceived level of disability was measured using the Oswestry Disability Index (ODI), higher scores indicate a greater degree of disability (0–100).²² This measure has 'acceptable' validity and reliability (Cronbach's $\alpha=0.76$).²³ The test-re-test reliability ranges from 0.83 to 0.99 depending on the length of time in between tests, this is felt to reflect the natural

variation in patients' symptoms.²² Health status was measured using the visual analogue scale (VAS) from the EQ5D.²⁴ Participants were asked to indicate their health on a scale of 0 (worst imaginable health state) to 100 (best imaginable health state). This scale has been shown to be reliable with an intra-class correlation coefficient of 0.8.²⁵ Participants were also asked to complete depression (Patient Health Questionnaire-9 (PHQ-9)) and anxiety (Generalised Anxiety Disorder-7 (GAD-7)) questionnaires. The PHQ-9 is a common screening tool for depression and gives a score from 0 to 27.²⁶ This measure is reliable (Cronbach's $\alpha=0.89$) and is highly sensitive at detecting depression.²⁷ The GAD-7 is also commonly used to screen for anxiety as it is a sensitive and reliable measure and gives a score from 0 to 21 (Cronbach's $\alpha=0.89$).²⁸ All questionnaires were completed pre-treatment (step 3) and post-treatment (step 23).

The web-based programme also collected online 'tracker' data each time participants logged into PTP. This asked them to indicate their current level of pain, problems in life due to pain and confidence managing their pain out of 100 on a VAS. The data from their first login (pre-treatment) and their final login (post-treatment) was analysed.

National Health Service (NHS) hospital health care usage was collected for the year before entering the service and for the year after entering the service. Participants' use of Accident and Emergency and inpatient and outpatient services, including the medical specialities utilised, were extracted from the Hospital Episode Statistics database. Costings for the usage were assigned using the NHS National Tariff Workbooks 2016/17.²⁹

Procedure

The evaluation of PTP was approved by the Trust audit group. As this is an evaluation of routine clinical care, ethical approval was not required. Posters and leaflets about PTP were given to physiotherapists to recruit suitable participants based on the inclusion criteria below. Referrals were received from physiotherapists working within the local community-based musculoskeletal service or by staff within the local chronic pain management service. Referral suitability was determined through a screening process carried out by a clinical psychologist working within the local chronic pain management service. Participants were sent a 'Client Information Form', and written informed consent was obtained from all participants before the study. Returned 'Client Information Forms' were then reviewed; where necessary, further information was obtained from general practitioners (GPs) or through telephone-based risk assessments with participants.

Participants who were identified as having a ‘mental health condition’ were also contacted to determine whether they felt this was a priority over pain management at this time. People whose referrals were judged to be suitable were assigned onto the programme and were sent an email with activation instructions. Participants were required to activate their account and work through the PMP. Telephone and email support was offered throughout as well as a consultation upon completion to review progress.

Participants

A total of 837 people were referred to the programme, of these, 99 (12%) did not meet the study criteria, resulting in a net total of 738 (88%) participants. Of these, 438 (59%) participants accessed the PTP account allocated to them (engagers) and 300 (41%) did not engage with the programme (non-engagers). Of those who engaged, 179 (41%) participants completed the programme and 259 (59%) started but did not complete it. The average age of participants was 48 ($N=738$) and ranged from 18 to 92. The sample contained 170 males (23%) and 568 females (77%). The average duration of pain based on the 479 participants who provided this information was 8 years.

Referrers were generally able to identify suitable participants for PTP with 88% of referrals found to be appropriate. However, 99 referrals were identified by screening as unsuitable mainly due to a lack of access to the Internet, being more suitable for a face-to-face programme or pursuing medical assessment or intervention for their pain management. The flow chart in Figure 1 provides more detailed information regarding the referral process.

The inclusion and exclusion criteria were as follows:

Inclusion criteria:

- English speaker;
- Chronic pain, not due to cancer or inflammatory disease, of ≥ 6 months duration;
- No indication of need for further medical or surgical investigation or treatment for pain;
- Access to Internet and emails;
- Pain associated with significant disability and/or distress.

Exclusion criteria:

- Cannot manage the physical or psychological demands of the programme;
- Does not think a self-management approach is appropriate for them;
- Believes they are coping adequately with their pain;

Figure 1. Study flow diagram.

- Does not have a Buckinghamshire GP or agreed contract with the Buckinghamshire Healthcare NHS Trust;
- Severe mental health condition which will affect the ability to complete programme;
- Under 18.

Data analysis

Data analysis was conducted using SPSS and Excel with a significance level set at 0.05. The analysis of the clinical outcome measures and tracker data included only those who completed PTP and had data for pre- and post-questionnaires. Descriptive statistics were calculated, and paired samples *t* tests were used to analyse these data. Demographic and clinical differences between groups were analysed using chi-square and independent samples *t* tests.

Microsoft Excel was also used to investigate whether any changes from pre- to post-scores met the definitions for a clinically significant change or a reliable change. A clinically significant change can be defined as a change in a patient's scores, whereby, following treatment, their scores are closer to that of the 'functional population' than the 'dysfunctional population'. Alternatively, reliable change measures how much change has occurred following treatment and whether this amount of change is significant.³⁰

Table 1. Means, standard deviations, effect sizes and correlations for participants' questionnaire scores before and after completing PTP.

Measures	Pre-programme Mean (SD) N = 177	Post-programme Mean (SD) N = 177	Significance value (p)	Effect size (d_{RM})	Correlation (ρ)
ODI (disability)	35.92 (15.59)	30.91 (16.51)	<0.001	0.50	0.803
EQ-VAS (perceived health status)	47.79 (23.36)	57.38 (24.75)	<0.001	0.44	0.588
PHQ-9 (depression)	8.88 (6.58)	6.80 (6.32)	<0.001	0.42	0.704
GAD-7 (anxiety)	7.85 (5.56)	6.10 (5.39)	<0.001	0.36	0.609

PTP: pathway through pain; SD: standard deviation; EQ-VAS: EuroQol-visual analogue scale; PHQ-9: Patient Health Questionnaire-9; GAD-7: Generalised Anxiety Disorder-7.

The cost data were analysed using Excel and converted to show cost savings per head.

Results

Does a web-based PMP lead to improved clinical outcomes?

As the data met the assumptions for parametric analysis, paired samples *t* tests were used to analyse the clinical and 'tracker' data. Effect sizes were calculated using Cohen's *d* (Mean 1 minus Mean 2, divided by pooled standard deviation).³¹ This was then adjusted for the within-subjects (repeated measures) design as recommended by Morris and DeShon.³² The effect size adjusted for repeated measures design is referred to as d_{RM} . In the equation below, ρ is the correlation between pre- and post-measures

$$d_{RM} = \frac{d_{IG}}{\sqrt{2(1-\rho)}}$$

Although 179 participants completed the course, 2 declined to complete the post-programme questionnaire measures, making the total sample size for the pre-post analysis 177. Means, standard deviations, effect sizes and correlations can be seen in Table 1.

Participants' disability scores on the ODI significantly reduced following PTP $t(176)=6.59$. Their perceived health status significantly improved from pre- to post-treatment, $t(176)=-5.84$. Participants also showed significant reductions in depression, $t(176)=5.56$, and anxiety, $t(176)=4.80$, following PTP.

Scatter plots seen in Figures 2–4 plot no change, reliable improvements and reliable deterioration lines. Reliable change was calculated using the Jacobson and Truax³⁰ definition that states that, following treatment, a reliable improvement has occurred if the mean of the participant is closer to that of the functional population than that of the dysfunctional population.

A single value for reliable change in ODI scores has not been universally agreed upon, but among lower back pain patients, it is defined as a change of 9 or more.³³ Of

Figure 2. A scatter plot of participants' pre- and post-ODI scores.

Figure 3. A scatter plot of participants' pre- and post-PHQ-9 scores.

Figure 4. A scatter plot of participants' pre- and post-GAD7 scores.

participants whose initial score was 9 or more and had data for pre- and post-time points ($N=174$), 58 (33.3%) reliably reduced their reported level of disability. On the other hand, of all the participants with pre- and post-disability data ($N=177$), 16 (9%) reliably increased their reported level of disability.

A reliable change in PHQ-9 scores is a change of 6 or more from pre to post.³⁴ Of the participants whose initial score was 6 or more and had data for pre- and post-time points ($N=109$), 37 (33.9%) experienced a reliable improvement in depression scores. In contrast, of all the participants with pre- and post-PHQ-9 data ($N=177$), six (3.4%) experienced a reliable deterioration in their depression scores. A score of 10 or above on the PHQ-9 means that a patient's score is closer to the average score of the 'dysfunctional population', which suggests a clinical level of depression. Of those who had data for pre- and post-measures and had a pre-treatment PHQ-9 score of 10 or more ($N=71$), 32 (45.1%) experienced a clinically significant change and no longer showed clinical levels of depression post-treatment.

A reliable change in GAD7 scores is a change of 4 or more from pre to post.³⁴ Of the participants whose initial score was 4 or more and had data for pre- and post-time points ($N=134$), 49 (36.6%) experienced a reliable improvement in their anxiety scores. On the other hand, of the participants with data for pre- and post-measures ($N=177$), 15 (8.47%) made a reliable deterioration in anxiety scores following PTP. A score of 8 or above on the GAD7 suggests that a patient's score is closer to the mean of the 'dysfunctional population' which suggests a clinical level of anxiety. Of those with pre-treatment GAD7 scores of 8 or more and data for pre- and post-measures ($N=75$), 38 (50.7%) made a clinically significant change and no longer showed clinical levels of anxiety post-treatment.

'Tracker' data concerning participants' pre- and post-levels of pain, problems in life due to pain and confidence managing their pain were also analysed. All participants who completed PTP provided pre- and post-data for this tracker data, so the sample size used in the analysis was 179. Means, standard deviations, effect sizes and correlations can be seen in Table 2. Results showed that participants were significantly more confident managing their pain following treatment, $t(179) = -6.27$. They reported significantly fewer problems in life due to pain following PTP, $t(179) = 8.82$. Participants' level of pain also significantly reduced after treatment, $t(179) = 4.69$.

Do age, gender or duration of pain affect engagement with, or completion of, a web-based PMP?

Comparisons were made between participants who engaged with PTP ($N=438$) and those who did not engage with the programme ($N=300$), results can be seen in Table 3. Independent samples t tests showed that those who accessed PTP were not significantly different to non-engagers in terms of age. A chi-square analysis also revealed that engagers were not significantly different in gender to non-engagers. Of those who provided information regarding their duration of pain, engagers had had pain for significantly less time than non-engagers, $t(477) = -2.1$, $d = -0.23$.

Comparisons were then drawn between those who completed PTP ($N=179$) and those who accessed PTP but did not complete the programme ($N=259$). Independent samples t tests revealed that completers were significantly older than non-completers, $t(436) = 4.89$, $d = 0.47$. There was no significant difference in completers or non-completers duration of pain. A chi-square analysis also revealed no significant differences in gender between completers and non-completers.

As all of these participants initially accessed the programme, most of them had pre-programme data for the clinical outcome measures. Independent samples t tests showed that those who completed PTP were significantly less depressed at the start of the course than those who did not complete, $t(357) = -2.00$, $d = -0.21$. There were no other significant differences between completers and non-completers in terms of pre-programme anxiety, disability or perceived health status.

Does a web-based PMP reduce health care-related costs?

Data for patients' NHS hospital usage the year before and the year after being referred to PTP were analysed. These data were split into A&E, outpatient and inpatient usage. The mean difference between participants'

Table 2. Means, standard deviations and effect sizes and correlations for participants' tracker scores before and after completing PTP.

Measures	Pre-programme Mean (SD) N = 179	Post-programme Mean (SD) N = 179	Significance value (<i>p</i>)	Effect size (<i>d_{RM}</i>)	Correlation (<i>ρ</i>)
Confidence managing pain	44.44 (18.98)	55.78 (23.35)	<0.001	0.5	0.433
Problems in life due to pain	66.16 (22.38)	50.61 (26.61)	<0.001	0.67	0.548
Pain level	57.33 (22.47)	48.45 (25.75)	<0.001	0.35	0.454

SD: standard deviation; PTP: pathway through pain.

Table 3. Mean scores for groups.

	Completers	Non-completers	Significance value (<i>p</i>)	Engagers	Non-engagers	Significance value (<i>p</i>)
Age	51.68 (13.21) N = 179	45.58 (12.58) N = 259	<0.001	48.08 (13.18) N = 438	47.59 (13.91) N = 300	0.63
Gender	Male = 41, 23% Female = 13, 8 77%	Male = 59, 23% Female = 200, 77%	0.98	Male = 100, 23% Female = 33, 8 77%	Male = 70, 23% Female = 230, 77%	0.87
Pain duration	7.81 (9.55) N = 154	7.49 (8.32) N = 222	0.73	7.62 (8.83) N = 376	9.73 (9.88) N = 103	0.04
Pre-PHQ-9 score	8.93 (6.66) N = 179	10.33 (6.64) N = 180	0.046			
Pre-GAD7 score	7.89 (5.62) N = 179	8.70 (5.65) N = 180	0.176			
Pre-ODI score	36.11 (15.80) N = 179	34.93 (17.16) N = 180	0.501			
Pre-EQ-VAS score	47.67 (23.59) N = 179	45.91 (23.72) N = 179	0.481			

EQ-VAS: EuroQol-visual analogue scale; PHQ-9: Patient Health Questionnaire-9; GAD-7: Generalised Anxiety Disorder-7; ODI: Oswestry Disability Index.

Standard deviations are shown in parentheses. As the non-engagers did not begin the programme, no pre-treatment scores were available to compare engagers with non-engagers.

per head usage the year before PTP and the year after can be seen in Table 4.

The above data include all of participants' hospital care including A&E, outpatient and inpatient contacts. The cost of health care for those who engaged in the programme was £240.30 less per patient than those who did not engage.

Discussion

Summary of results

This study explored the potential benefits of a web-based PMP for chronic pain in terms of clinical effectiveness and health care cost savings. In regard to the first research question, participants who completed PTP made significant improvements in their perceived health status, level of disability, depression, anxiety, confidence managing pain, problems in life due to pain and level of pain. Around one-third of participants experienced reliable changes in their levels of disability,

Table 4. The per-head difference in costs related to NHS use from the year before referral to PTP and the year after referral.

	Engagers (N = 438)	Non-engagers (N = 300)
A&E difference	-£14.45	-£9.93
Inpatient difference	-£118.13	£47.03
Outpatient difference	-£20.35	£50.27
Overall difference	-£152.93	£87.37

NHS: National Health Service; PTP: pathway through pain.

depression and anxiety. In addition, approximately half of those with pre-treatment scores above the clinical cut-off for depression and/or anxiety no longer met the cut-off post-treatment. The second research question looked at whether engagement with, or completion of, PTP was associated with age, gender or duration of pain. No differences were found in age or gender between those who engaged with treatment and those

who did not. On average those who engaged with the programme had a shorter duration of pain. With respect to completion of the programme, no differences were found for gender or duration of pain. However, those who completed the programme were on average older. Regarding our final research question, the available data suggest that PTP may have resulted in health care cost reductions as those who engaged with PTP showed reduced health care costs in the year after referral, whereas health care costs of non-engagers increased.

Comparisons with previous literature

This study provides results from a real-world setting, demonstrating the effectiveness of a web-based PMP. This confirms findings from RCTs that online PMPs can reduce levels of pain, disability, depression and anxiety.^{15,17} The mean effect size following PTP was 0.46 (range: 0.35–0.67). These effect sizes are larger than found in RCTs measuring the efficacy of traditional face-to-face PMPs, which show a mean effect size of 0.28 for changes in pain, mood and disability following treatment.³⁵ However, it is not possible to compare effect sizes from a within-subjects pre–post test design with RCTs included in meta-analyses, which are likely to provide a much more conservative estimate of change. The current findings are also similar to those seen in real-world effectiveness trials of face-to-face PMPs, which demonstrated effect sizes from the upper end of small to medium.⁹ This study adds to the broader literature indicating that web-based PMPs can be as effective as face-to-face treatments.^{15,36} Given the encouraging findings from this study, and previous literature, web-based PMPs may be an additional treatment option for pain management services.

There was no relationship between gender or age and engagement with PTP; however, participants with shorter duration of pain were more likely to engage. Participants who were less depressed at the start of the programme were more likely to complete. This is in line with wider literature showing individuals with depression are less likely to remain in treatment.³⁷ This could be a particular problem for digital interventions where the lack of therapist support could affect engagement and persistence in treatment for people with comorbid depression. Older participants were more likely to complete the programme than younger participants. This finding is consistent with the literature, showing younger people are more likely to drop out of therapy than older people.³⁸ This finding is of interest because older people are more likely to be affected by chronic pain and face barriers preventing them from attending face to face

treatment.³⁹ However, as participants in this study were not randomised, it is difficult to draw firm conclusions about predictors of treatment engagement or completion. Previous studies have generally not found any consistent links between personal characteristics and outcome of digital interventions.⁴⁰ A favourable interpretation might be that this suggests that digital interventions are helpful to people with chronic pain regardless of personal characteristics. However, as Nicholl et al.¹⁹ note, participants are predominantly middle-aged, White, well-educated females and therefore their results may not be widely generalisable.

The results show that people who engaged in the web-based PMP have reduced health care costs over the following year, compared to those who did not access the programme. Similarly, in a systematic review, Pike et al.¹¹ report a reduction in health care contacts following face-to-face PMPs. However, as this review examined health care utilisation rather than per capita cost savings, direct comparisons cannot be made with the present study. A Dutch study found that an Internet-based PMP was at least as cost-effective as their face-to-face group PMP.⁴¹ The cost of visits to health professionals following participation were €649 in the Internet course versus €707 in the group course. More generally, a meta-analysis conducted by Chiles et al.⁴² reports that average dollar savings from implementing psychological interventions are around 20% of medical costs. While it may be difficult to compare findings across different health care systems, this evidence suggests that web-based PMPs, like face-to-face PMPs, may be an effective way of reducing health care costs.

Limitations of the study

The study has several limitations, first, the lack of a control group. Although participants who did not access the programme can serve as a form of comparison group, they were not randomly allocated. Therefore, the differences found in clinical outcomes, health care utilisation and variables associated with engagement and completion could be explained by factors such as baseline differences between the groups and need to be interpreted with caution. However, there are already a number of RCTs of the efficacy of digital treatment for chronic pain.^{15,17} The current study instead provides real-world evidence for the effectiveness of web-based pain management from a genuine clinical setting.

Second, to identify people for whom an online programme would be helpful, participants were first screened by physiotherapists. There is potential for bias in the selection process, as the physiotherapists may have been overly selective in their application of the

exclusion criteria. This could mean that people who might have benefitted from the programme were denied access, and that the sample may not have been representative.

Third, the drop-out rate for the treatment is high, with less than half of the participants completing the programme. This is likely to inflate estimates of the benefits of the intervention. Macea et al.¹⁵ observed that this was a common issue with studies of digital interventions. They suggested that comparing the differences between the remaining participants and those that dropped out might elucidate reasons for this. In line with this approach, the present study showed that participants who dropped out had, on average, higher levels of depression. This finding needs to be considered when developing and implementing digital interventions. It might be beneficial to consider measures that could be taken to increase the rate of completion. For example, guided self-help has been demonstrated to be more effective than unsupported self-help in reducing drop-out rates by up to 30–40% in Internet-based treatments.⁴³ On the other hand, larger drop-out rates may be less problematic in digital interventions as there is a greater capacity for treatment than there is for face-to-face programmes. As providing support increases the cost of treatment, one may have to consider whether the increase in engagement is of sufficient benefit to warrant this. Another way to increase engagement with digital products could be by including technology-based engagement strategies such as prompts, peer comparisons and using social reward. These strategies have been demonstrated to be slightly more effective in increasing engagement than using no technology-based strategies.⁴⁴

Fourth, the evaluation did not collect follow-up data on clinical outcomes. Eccleston et al.¹⁷ report that few of the studies they reviewed included follow-up evaluations, and therefore it remains uncertain whether improvements would be maintained in the long term. However, this evaluation did monitor the cost savings per head at 1 year after referral, which may indicate benefits of participation post-treatment. It would be helpful for future studies to include long-term follow-up of clinical outcomes to determine whether benefits are maintained.

Finally, health care costs 1 year pre-referral were compared to health care costs in the year following referral. This means that in the post-referral period, participants were using PTP. It is possible this could affect use of health care services, as people may be less likely to seek help if they are receiving support from the digital programme. This method was used because the length of time participants accessed PTP varied considerably, so there was no consistent cut-off from which to measure post-intervention.

Suggestions for future research and clinical implications

This evaluation examined cost savings for hospital care and did not take into account the cost of delivery of the programme or use of other health care services, including GP visits. As only one element of health care costs was measured, the reported cost savings per head may overestimate or underestimate the true extent of savings. Future research could include cost savings for primary or community health care contacts such as GP visits, prescribing costs and work days lost due to illness. In addition, future research could also control for and investigate factors that might explain differences in health care usage post-treatment. Further research is, therefore, required to confirm that web-based PMPs are cost-effective.

The present study reported data on reliable deterioration in clinical outcomes. However, there has been little consideration of the potential harms of digital interventions in the literature, such as the rate of negative outcomes and the risk that these are not detected.⁴⁵ This area should therefore be a focus of future research.

With respect to clinical implications, a very large number of people in the United Kingdom are affected by chronic pain, but there is only limited capacity to treat people in existing specialist pain management services.^{1,46} Use of digital interventions could provide an additional cost-effective way of improving access to evidence-based treatments for a greater number of people with chronic pain. Those with the potential to benefit from digital interventions could be offered this first and if they need further help they could be stepped up to face-to-face programmes.⁴⁷

Conclusion

This study provides evidence for the effectiveness of web-based PMPs in reducing participants reported level of pain and disability, depression and anxiety. In addition, the available evidence suggests that those who engaged with the programme may have had reduced health care costs in the year following referral. Web-based PMPs may be an effective alternative to face-to-face interventions for some people with chronic pain and might be employed to meet some of the unmet demand for treatment.

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Conflict of interest

Dr Theo John Pimm and Dr Ranjeeta Lota are Clinical Psychologists working at the Buckinghamshire Chronic Pain

and Fatigue Management Service and Laura Williams, Megan Reay, Laura Coote and Ciara Maloney are former employees of the trust. Wellmind Media have kindly provided the Buckinghamshire Chronic Pain Service with complimentary licences for the online programme.

Author contribution

Dr Theo John Pimm is the lead researcher and wrote the manuscript; Laura Williams contributed to data collection, performed the literature review, and wrote the manuscript; Megan Reay analysed the data, wrote the manuscript and performed the literature review; Stephen Pickering extracted health economic data; Dr Ranjeeta Lota, Laura Coote and Ciara Maloney were research assistants and contributed to participant recruitment and data collection; Firas Sarhan performed project initiation and supervision; and David Hancock contributed to data analysis.

Ethical approval

The evaluation of pathway through pain (PTP) was approved by the Trust audit group. As this is an evaluation of routine clinical care, ethical approval was not required.

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Guarantor

TJP is the guarantor of this article.

Informed consent

Patients were sent a client information form and a questionnaire to complete, and written informed consent was obtained from all subjects before the study.

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References

1. Fayaz A, Croft P, Langford RM, et al. Prevalence of chronic pain in the UK: a systematic review and meta-analysis of population studies. *BMJ Open* 2016; 6(6): e010364.
2. Donaldson LJ. Pain: breaking through the barrier. 150 years of the annual report of the Chief Medical Officer: on the state of the public health. *Report, Department of Health, London*, 2008, https://webarchive.nationalarchives.gov.uk/20130105045448/http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/documents/digitalasset/dh_096231.pdf
3. Rayner L, Hotopf M, Petkova H, et al. Depression in patients with chronic pain attending a specialised pain treatment centre: prevalence and impact on health care costs. *Pain* 2016; 157(7): 1472–1479.
4. Gaskin DJ and Richard P. The economic costs of pain in the United States. *J Pain* 2012; 13(8): 715–724.
5. Scottish Intercollegiate Guidelines Network (SIGN). *Management of chronic pain (SIGN 136)*, 2013, <https://www.sign.ac.uk/assets/sign136.pdf> (accessed 4 October 2018).
6. Fordyce WE, Fowler RS Jr, Lehmann JF, et al. Some implications of learning in problems of chronic pain. *J Chronic Dis* 1968; 21(3): 179–190.
7. Keefe FJ, Rumble ME, Scipio CD, et al. Psychological aspects of persistent pain: current state of the science. *J Pain* 2004; 5(4): 195–211.
8. Eccleston C, Williams ACDC and Morley S. Psychological therapies for the management of chronic pain (excluding headache) in adults. *Cochrane Database Syst Rev* 2009, <https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD007407.pub2/abstract> (accessed 21 January 2018).
9. Morley S, Williams ACDC and Hussain S. Estimating the clinical effectiveness of cognitive behavioural therapy in the clinic: evaluation of a CBT informed pain management programme. *Pain* 2008; 137(3): 670–680.
10. Barkham M and Mellor-Clark J. Bridging evidence-based practice and practice-based evidence: developing a rigorous and relevant knowledge for the psychological therapies. *Clin Psychol Psychother* 2003; 10(6): 319–327.
11. Pike A, Hearn L and Williams ACDC. Effectiveness of psychological interventions for chronic pain on health care use and work absence: systematic review and meta-analysis. *Pain* 2016; 157: 777–785.
12. Garg S, Garg D, Turin TC, et al. Web-based interventions for chronic back pain: a systematic review. *J Med Internet Res* 2016; 18(7): e139.
13. Strom L, Pettersson R and Andersson G. A controlled trial of self-help treatment of recurrent headache conducted via the Internet. *J Consult Clin Psychol* 2000; 68(4): 722–727.
14. Wantland DJ, Portillo CJ, Holzemer WL, et al. The effectiveness of Web-based vs. non-Web-based interventions: a meta-analysis of behavioral change outcomes. *J Med Internet Res* 2004; 6(4): e40.
15. Macea DD, Gajos K, Daglia Calil YA, et al. The efficacy of Web-based cognitive behavioral interventions for chronic pain: a systematic review and meta-analysis. *J Pain* 2010; 11(10): 917–929.
16. Sirey JA, Bruce ML, Alexopoulos GS, et al. Stigma as a barrier to recovery: perceived stigma and patient-rated severity of illness as predictors of antidepressant drug adherence. *Psychiatr Serv* 2001; 52(12): 1615–1620.
17. Eccleston C, Fisher E, Craig L, et al. Psychological therapies (Internet-delivered) for the management of chronic pain in adults. *Cochrane Database Syst Rev* 2014, <https://www.cochranelibrary.com/cdsr/doi/10.1002/14651858.CD010152.pub2/full> (accessed 21 January 2018).
18. Dear BF, Gandy M, Karin E, et al. The Pain Course: a randomised controlled trial examining an internet-delivered pain management program when provided with

- different levels of clinician support. *Pain* 2015; 156(10): 1920–1935.
19. Nicholl BI, Sandal LF, Stochkendahl MJ, et al. Digital support interventions for the self-management of low back pain: a systematic review. *J Med Internet Res* 2017; 19(5): e179.
 20. Steckler A and McLeroy KR. The importance of external validity. *Am J Public Health* 2018; 98: 9–10.
 21. Wellmind Media, <https://www.wellmindmedia.com/> (accessed 10 January 2018).
 22. Fairbank JC, Couper J, Davies JB, et al. The Oswestry low back pain disability questionnaire. *Physiotherapy* 1980; 66: 271–273.
 23. Fairbank JC and Pynsent PB. The Oswestry disability index. *Spine* 2000; 25: 2940–2952.
 24. The EuroQol Group. EuroQol – a new facility for the measurement of health-related quality of life. *Health Policy* 1990; 16(3): 199–208.
 25. Wilke C and Pickard A. Test-retest reliability of the EQ-5D visual analogue scale across populations and conditions. In: *Proceedings of the scientific meeting of the EuroQol Group*, Paris, 13–15 September 2009, vol. 26, pp. 165–172. Rotterdam: EuroQol Office.
 26. Spitzer RL, Kroenke K and Williams JBW. Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. Primary Care Evaluation of Mental Disorders. Patient Health Questionnaire. *JAMA* 1999; 282: 1737–1744.
 27. Kroenke K, Spitzer RL and Williams JBW. The PHQ-9: validity of a brief depression severity measure. *J Gen Intern Med* 2001; 16(9): 606–613.
 28. Spitzer RL, Kroenke K, Williams JBW, et al. A brief measure for assessing generalized anxiety disorder: the GAD-7. *Arch Intern Med* 2006; 166(10): 1092–1097.
 29. NHS. National tariff workbooks, <https://improvement.nhs.uk/resources/national-tariff-1719/> (2016–2017, accessed 3 January 2018).
 30. Jacobson NS and Truax P. Clinical significance: a statistical approach to defining meaningful change in psychotherapy research. *J Consult Clin Psychol* 1991; 59(1): 12–19.
 31. Cohen J. *Statistical power analysis for the behavioral sciences*. New York: Academic Press, 1988.
 32. Morris SB and DeShon RP. Combining effect size estimates in meta-analysis with repeated measures and independent-groups designs. *Psychol Methods* 2002; 7(1): 105–125.
 33. Lauridsen HH, Hartvigsen J, Manniche C, et al. Responsiveness and minimal clinically important difference for pain and disability instruments in low back pain patients. *BMC Musculoskelet Disord* 2006; 7: 82.
 34. Clark D and Oates M. Improving access to psychological therapies: measuring improvement and recovery adult services, version 2. *Report, NHS England, Leeds*, June 2014.
 35. Williams ACDC, Eccleston C and Morley S. Psychological therapies for the management of chronic pain (excluding headache) in adults. *Cochrane Database Syst Rev* 2012; 11: CD007407.
 36. Andersson G, Cuijpers P, Carlbring P, et al. Guided Internet-based vs. face-to-face cognitive behavior therapy for psychiatric and somatic disorders: a systematic review and meta-analysis. *World Psychiatry* 2014; 13: 288–295.
 37. Melville KM, Casey LM and Kavanagh DJ. Dropout from Internet-based treatment for psychological disorders. *Br J Clin Psychol* 2010; 49(Pt 4): 455–471.
 38. Edlund MJ, Wang PS, Berglund PA, et al. Dropping out of mental health treatment: patterns and predictors among epidemiological survey respondents in the United States and Ontario. *Am J Psychiatry* 2002; 159: 845–851.
 39. Molton IR and Terrill AL. Overview of persistent pain in older adults. *Am Psychol* 2014; 69(2): 197–207.
 40. DasMahapatra P, Chiauzzi E, Pujol LM, et al. Mediators and moderators of chronic pain outcomes in an online self-management program. *Clin J Pain* 2015; 31(5): 404–413.
 41. De Boer MJ, Versteegen GJ, Vermeulen KM, et al. A randomized controlled trial of an Internet-based cognitive-behavioural intervention for non-specific chronic pain: an effectiveness and cost-effectiveness study. *Eur J Pain* 2014; 18(10): 1440–1451.
 42. Chiles JA, Lambert MJ and Hatch AL. The impact of psychological interventions on medical cost offset: a meta-analytic review. *Clin Psychol* 1999; 6: 204–220.
 43. Richards D and Richardson T. Computer-based psychological treatments for depression: a systematic review and meta-analysis. *Clin Psychol Rev* 2012; 32(4): 329–342.
 44. Alkhaldi G, Hamilton FL, Lau R, et al. The effectiveness of prompts to promote engagement with digital interventions: a systematic review. *J Med Internet Res* 2016; 18(1): e6.
 45. Andersson G and Titov N. Advantages and limitations of Internet-based interventions for common mental disorders. *World Psychiatry* 2014; 13: 4–11.
 46. NHS England. Specialised services for pain management. *Report, NHS England*, 2013, <https://www.england.nhs.uk/wp-content/uploads/2013/06/d08-spec-serv-pain-mgt.pdf>
 47. National Institute for Health and Clinical Excellence (NICE). *Common mental health problems: identification and pathways to care: NICE guideline (CG123)*, 2011, <https://www.nice.org.uk/guidance/CG123/chapter/1-Guidance#stepped-care> (accessed 10 January 2018).

Appendix 1. Pathway through pain content.

Step	Title	Description
1	Getting started	Video introduction to the course
2	Know you're not alone	Video explaining that pain is common, written testimonials
3	Assess your condition	Video explaining questionnaires then complete them online
4	Know about chronic pain	Psychoeducation about chronic pain
5	Stress relief	Relaxation video and breathing exercise
6	Observe your response to pain	Psychologist video introducing private online journal to record pain level, stress, response and so on
7	Stretch your body	Physiotherapist video explaining benefits of exercise and introducing some stretches
8	Release tension in your body	Video explaining link between tension and pain flare ups, relaxation video and exercises
9	Set some goals	Explain SMART goals and set three of your own
10	Pace yourself	Explain pacing and asks about patient's pacing
11	Recognise unhelpful thoughts	Explain link between thoughts, feelings and pain
12	Don't rely on a physical cure	Psychoeducation about medication side effects. Patients tick all treatments they have tried and rate them. Then see how helpful or not others found them
13	Use pain-relief techniques	Guided meditation and mindfulness video
14	Build up your tolerance	Physiotherapist video explaining de-conditioning
15	Become more active	Gradually increase exercise, motivational video
16	Relax deeply	Relaxing suggestions, total relaxation video
17	Challenge your thoughts	Tick applicable thoughts then change to be more helpful
18	Exercise your body	Benefits of exercise, introduces new stretches
19	Sleep better	Sleep hygiene psychoeducation
20	Manage your medication	Pros and cons of taking medication long term, risks and side effects of long-term use
21	Gain support from others	How to communicate about pain, and how to ask for support when needed
22	Deal with set backs	Set back/flare-up planning
23	Reclaim your life	Reflect on goals and re-complete questionnaires
24	Engage with the future	Summary, explain should continue using techniques
25	Keep going	Opportunity to give feedback, end of course
26	Follow-up	One month later, re-complete questionnaires. Only open 4–5 weeks after completion then closes again