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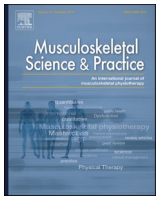

An evaluation of a one-day pain science education event in a 16–18 years school setting targeting pain-related beliefs, knowledge, and behavioural intentions: A mixed-methods, non-randomised controlled trial☆

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A B S T R A C T

Background: Public understanding of persistent pain is fraught with misconceptions. Pain education in schools may improve public understanding long-term. This study evaluated the impact of a one-day Pain Science Education (PSE) public health event delivered in a 16–18 year old school setting.
Methods: This was a multi-site, non-randomised controlled, mixed-methods study with three data collection time points: baseline, post intervention, and three-month follow-up. Participants were high school students ≥16 years old. Pain beliefs, knowledge, and behavioural intentions were assessed with the Pain Beliefs Questionnaire (PBQ [organic and psychological subscales]), Concepts of Pain Inventory (COPI-Adult), a case vignette, and reflexive thematic analysis of semi-structured interviews.
Results: Thirty intervention (mean age 16.6 years, 37 % female, 63 % male) and 24 control group participants (16.9 years, 63 % female, 37 % male) were recruited. Attending the pain education event was associated with reductions in Organic Beliefs [mean difference −4.4 (95 % CI, −6.0, −1.9)] and increases in Psychological Beliefs [4.6 (2.7, 6.4)] compared to the control group. This represents a shift away from biomedical beliefs in the intervention group compared to the control group. This shift was partially sustained at 3 months. A similar pattern was seen for the COPI-Adult and case vignette assessments. Semi-structured interviews (n = 13) identified an increased awareness of chronic pain and varying degrees of reconceptualisation of pain towards a biopsychosocial understanding.
Conclusions: Attendance at a one-day PSE-based public health event was associated with improved knowledge, beliefs, and behavioural intentions regarding persistent pain. This exploratory study supports the need for a robust mixed-methods RCT of pain education for school children with long-term follow-up.

1. Introduction

Persistent pain is a significant problem in children and adults. The prevalence of significant persistent musculoskeletal pain in UK adults is 23 % (Fayaz et al., 2016). It is associated with significant disability affecting employment, financial security depression, anxiety, sleep, adverse social conditions, medication overuse, and cognitive impairment (Lerman et al., 2015; McCracken and Iverson, 2002; Thomas et al., 2024; Health and Safety Executive, 2024). In children aged ≤19 pain prevalence is estimated to average 20.8 % internationally (Chambers et al., 2024).

Children with persistent pain report lower levels of physical activity, reduced school attendance and fewer friends (Wilson and Palermo, 2012; Logan et al., 2008; Forgeron et al., 2015). Furthermore, persistent pain in childhood is associated with an increased likelihood of persistent pain, anxiety disorders, and depressive disorders in adulthood (Noel et al., 2016; Murray et al., 2020, Walker et al., 2010; Tollisen et al., 2019).

☆ Ethical approval was gained from Teesside University SHLS Sub-Committee in 2023.

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Incorrect understanding about persistent pain is common and often biomedically grounded. These misconceptions can negatively impact multiple pain related factors including level of disability and duration of pain symptoms (Hill et al., 2016; Campbell et al., 2013; Taylor and Bishop, 2020; Caneiro et al., 2021). Additionally, biomedical beliefs increase the likelihood of people undertaking behaviours that are contrary to clinical guidelines for managing persistent pain. These behaviours include bed rest, avoiding activity for fear of increasing perceived damage to tissue, and taking medications that do not ease pain but may have side effects (Caneiro et al., 2021). These beliefs foster unhelpful behaviours contributing to persisting pain. Patients with these beliefs are less inclined to opt for evidence-based biopsychosocial approaches (Ryan et al., 2024). There have been multiple calls to address public misconceptions about persistent pain within all sectors of society (Johnson et al., 2023; Fitzcharles et al., 2021; Moseley, 2003; Ryan et al., 2024).

There may be a particular benefit in targeting school children with pain education as it provides the information to children at a point when a sizable proportion already have persistent pain or are at risk of developing it thus it may help to reduce future impacts of their pain (Ickmans et al., 2022). Similarly, it may be one of the best strategies to improve long term adult understanding of pain in a way that ensures equity of information for all sections of society in those societies where schooling is compulsory, thus targeting potential health inequalities (Jourdan et al., 2021). School-going age could be a key point at which to shape accurate health beliefs for future adults leading to long term shifts in public beliefs (Pate, 2022; Marks et al., 2011). This may reduce experiences of pain in the future and health service utilisation (Suman et al., 2021; Buchbinder, 2008; Sharma et al., 2021). Successful public health campaigns outside the field of pain have targeted schools in areas such as tobacco control, vehicle safety, internet safety and mental health awareness (Gielen and Green, 2015; Herlitz et al., 2020; Lindow et al., 2020; Department for Education. Guidance, 2023).

Preventative educational interventions targeting pain beliefs may have wider benefits for addressing future pain (Hassett et al., 2013), reducing restrictions to participation in usual activities, and stigma from peers (Wakefield et al., 2021). There is a need to ensure that young people are well equipped with correct information about pain to reduce the impact of pain in their youth and in adulthood. Furthermore, older children particularly can influence adult attitudes and behaviours (Kuczynski et al., 2016). Thus, it is feasible that children in the intervention group could influence different behaviours and attitudes to persistent pain amongst their family elders.

Pain science education (PSE) is a biopsychosocial approach to pain education, underpinned by educational psychology, which seeks to give individuals a more contemporary scientific understanding of pain (Moseley et al., 2024). It has been shown that PSE can lead to improvements in understanding of pain and in pain related outcomes such as behaviour, willingness to be active, and disability in people with pain (Louw et al., 2018; Bagg et al., 2022; Watson et al., 2019). Changing beliefs and understanding of pain appear to mediate these improvements (Cashin et al., 2022; Ashar et al., 2023). Furthermore, PSE can improve pain knowledge and beliefs in children (Louw et al., 2018; Pintó et al., 2021; Kisling et al., 2021; Mankelow et al., 2023).

Recently, our group found that a one-day PSE event delivered as part of a public health campaign in a high school (ages 16 to 17) was associated with improvements in pain beliefs, knowledge, behavioral intentions, and increased openness to holistic management (Mankelow et al., 2023). 'Behavioural intention' is defined as 'a person's relative strength of intention to perform a behaviour' (Maffei et al., 2012). However, the study was a cross-sectional study, it did not have any follow up, and had only a small number of qualitative responses. The current study addresses some of the limitations of our previous work in providing PSE to the 16 to 17 age group with a one day PSE event and its impact on student perspectives on pain science in the short term and medium term. It is hypothesised that students from a different demographic to our previous study (Mankelow et al., 2023) will benefit from PSE and this will have a lasting effect in the medium term. This current study will inform the development of a future fully powered RCT.

1.1. Study aims and objectives

The aim of this study was to evaluate the impact of a one-day PSE event delivered within a UK high school setting. The event was held as part of the mandated curriculum (https://www.richmondschool.net/wp-content/uploads/2024/10/15.-Life-Y7-13-curriculum-overview.pdf) wherein general life skills are taught.

The primary objective was to observe any changes in student pain beliefs, using the Pain Beliefs Questionnaire (PBQ) after a one-day PSE event.

1.2. Secondary outcomes were

- Beliefs and knowledge using the COPI-Adult questionnaire.
- Participants' behavioural intention in the presence of pain, using a case vignette and a multiple-choice questionnaire.
- Qualitative exploration of the understanding of the PSE material.
- Qualitative exploration of the experience of receiving PSE from the students' perspective.
- To inform the development of a fully powered RCT.

2. Methods

2.1. Design

This mixed methods, multiple-site, non-randomised controlled trial was conducted in the northeast of England. High school students' pain beliefs, knowledge and behavioural intentions were quantified using three questionnaires at three time points, collected online on online-surveys.ac.uk. These were at baseline, after a one-day PSE focussed event delivered as part of the Flippin' Pain public health campaign (www.flippinpain.co.uk), and at three months follow up. Additionally, data about the participants' gender, age, and ethnicity were gathered (data categories applied were those used by the UK Government for the 2021 Census). Previous/current experience of pain data were collected by asking participants if they had experienced persistent pain in the muscles, joints, spine, bones and/or nerves which lasted for three months or more. Individuals who had current or previous pain were asked to identify the pain location. Qualitative data collected during face-to-face interviews post-intervention were reflexively thematically analysed (Braun & Clarke, 2019). The philosophical approach was pragmatism. Ethical approval was provided by University School of Health and Life Sciences Research Ethics Committee (reference number 2023 Jan 1, 1360 Mankelow). The study protocol was registered with clinicaltrials.gov on 01.02.23 (NCT05636345).

2.2. Sampling and participants

A non-randomised, convenience sample of students from two, mixed-gender, high schools in North Yorkshire (UK), aged $\geq$16 participated in this study. Both were state schools and part of the same Academy, in an area of similar ranking on the Index of Multiple Deprivation (IMD) (2019) based on the individual schools' postcodes. The average IMD rating score was 12.7 for the IG and 12.1 for the CG in a year of reporting where the lowest score was 0.5 in the UK and the highest was 92.7. The IMD combines information from seven domains including deprivation in income, employment, education, health, crime, barriers to housing and services and living environment, (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/853811/IoD2019_FAQ_v4.pdf). The intervention group were recruited from School A, year 12, ages 16–17 (from a sample frame of 80). The

control group were recruited from School A, year 13 (aged 17–18) and School B, year 12 and 13 (from a sample frame of 210).

In the absence of pilot data, an a-priori sample size calculation estimated that 134 participants in total were required to identify an effect size of 0.75 with a power of 99 % and an alpha = 5 %. Effect size was calculated using G*Power based upon Health Care Providers' Pain and Impairment Relationship Scale (HC-PAIRS) data, which assess beliefs about pain, from a previous study in health care students (Colleary et al., 2017). To allow for a drop-out rate of 20 % (Bell et al., 2013), a target sample of 160 participants was sought.

2.3. Intervention

The timetable and materials used for the day at School A can be found in supplementary material. They are reported in accordance with the TIDieR checklist which has been completed and attached in supplementary information (Hoffmann et al., 2014). The PSE event initially involved a 70-min didactic presentation, delivered by an experienced physiotherapist who frequently presents PSE (CR) with a 20-min Q&A session at the end. The intervention used Explain Pain explanations (Butler and Moseley, 2003), interactive exercises, metaphors and stories were used to

convey messages about pain science and theory, https://www.youtube.com/watch?v=m2pG08kL0PM. The content of the intervention was very similar to that used successfully in students of a similar age for an observational study (Mankelow et al., 2023) and to that used for adult pain science education.

A person with lived experience of persistent pain spoke of their experience and eventual self-management for approximately 10 min.

Following the presentation, participants were separated into small groups who engaged with a series of experiential learning activities; interactive experiences to reflect concepts discussed in the didactic session focussing on the role of the brain in perception. Students attended nine different learning stations during a 1-h period. At each station the experience required individuals to make sense of sensory illusions, visual illusions, and audio inputs, (including virtual reality), designed to challenge understanding of perception and allow them to explore how experiences can be influenced by multiple factors.

Finally, in small groups, attendees developed materials to convey pain information to family members or peers using a format of their choice such as posters, slideshows, Kahoot, and TikTok. The output of the groupwork was presented to peers in the other groups. At the end of the event, the groupwork challenge was peer judged and winners were each awarded £10 book vouchers.

2.4. Control group

Participants in the control group attended class as usual but completed all of the below outcome questionnaires listed below at three time points as the intervention group.

Quantitative data collection
Outcome measures
Primary Outcome

2.4.1. Pain beliefs - The Pain Beliefs Questionnaire (PBQ)

The Pain Beliefs Questionnaire (PBQ) includes 12-items (Edwards et al., 1992; Walsh and Radcliffe, 2002). Each item was scored on a 6-point scale ("always" to "never"). The questionnaire includes two sub-scales. The Organic Beliefs Subscale, assesses level of agreement with the structural pathology model (biomedical model) of pain. It is an eight-item scale, scores range from 8 to 48, lower scores indicate reduced biomedical beliefs. The other subscale, the Psychological Beliefs Subscale assesses beliefs about the effect of psychological factors on pain. It has four items and a score range of 4–24, and lower scores indicate reduced psychosocial beliefs. The PBQ has previously been used with individuals with and without pain (Baird and Haslam, 2013; Baird and Sheffield, 2016). The reliability is satisfactory for both subscales with good internal consistency, Cronbach >0.75, (Walsh and Radcliffe, 2002). Furthermore, Baird and Sheffield, 2016 observe that the subscales reflect both direct and mediated effects on key physical and mental health outcome measures. The European Knowledge Alliance advocates the use of the PBQ in assessing pain beliefs (Bellosta-López et al., 2021).

2.5. Secondary outcome

2.5.1. Pain knowledge and beliefs - the concept of Pain Inventory for adults (COPI-adult)

The COPI-Adult was designed for assessing knowledge and beliefs about pain science (Pate, 2022) in participants aged ≥18 years but has previously been used successfully with 16–18 year olds (Mankelow et al., 2023). It is a 13-item questionnaire with acceptable internal consistency ($\alpha = 0.78$), and good test-retest reliability (ICC(3,1) = 0.84 (95 %CI 0.71 to 0.91). Questions are scored on a five-point scale (strongly disagree '0' to strongly agree '4'), the scale ranges from 0 to 52. Higher scores reflect greater alignment with contemporary pain science.

2.5.2. Behavioural intentions about pain - case vignette

Participants completed a case vignette (Supplementary material) to assess their behavioural intentions. The case vignette was of an individual experiencing pain, adapted from previously published case vignettes (Bishop et al., 2008; Colleary et al., 2017; Mankelow et al., 2020). Participants were asked what actions they would take if they had pain with regards to medication, medical imaging, daily activity, exercise, and work/school attendance either based on yes/no answers or four/five multiple choice answers. Case vignettes are a commonly used and valid way to assess behavioural intentions (Peabody et al., 2000; Bishop et al., 2008; Cope et al., 2016).

2.5.3. Statistical analysis for quantitative data

All continuous data were normally distributed and presented as mean [standard deviation (SD)]. Demographic data were presented as percentages. It had originally been intended to analyse between group differences in the change scores for PBQ subscales and COPI-Adult using ANCOVA, adjusting for gender and previous pain experiences. However, there was a large drop out of participants between immediately post intervention and three months, and given the exploratory nature of this work, it was decided to report the data descriptively as mean change and 95 % confidence interval of the change to avoid over interpretation of the data. For the case vignette analysis, data were presented descriptively as frequency and percentage of correct answers. Mean effect sizes for each outcome measure were also established using Cohen's *d* using pre, post and three months post data and the SD for the pre-test group (Cohen, 1992). A meaningful change was determined to be 0.5, which would indicate a moderate effect size or above with effect sizes above 0.8 or great indicated a large effect size (Cohen, 1992).

2.5.4. Qualitative data analysis

Post intervention, all participants were invited to attend a semi-structured interview to discuss their understanding of pain and their experience of the project. The interview schedule can be found in supplementary material. Interviews were recorded and undertaken by SS, JM and AG via Microsoft Teams with automatic transcription. These were manually cross-checked again the audio and any mistranscriptions corrected. Reflexive thematic analysis of data was undertaken (Braun and Clarke, 2024). Transcripts were read multiple times to aid data familiarisation, and then provisionally coded by JM. Coded statements were then grouped together into themes. All views were treated equally. A second researcher (TL) collaborated in the analytic process to ensure the themes were logical and rooted in the data. The themes were then

discussed amongst the group. In keeping with reflexive thematic analysis, the focus of the sampling strategy was to achieve information power in addressing study aims rather than saturation (Malterud et al., 2016).

2.5.5. Reflexivity

Researcher background may influence data collection, analysis, and interpretation. To contextualise the findings, ten of the researchers (JM, NS, DR, RC, SB, AG, JWP, RN, JT and CR) have regular experience of delivering PSE to patients, clinicians and students. Three of the researchers (JP, DM and SS) do not have experience of PSE delivery. JM, DR, and CR are directly involved in the *Flippin' Pain* campaign. JWP teaches pain science education to healthcare students at university level and has created PSE resources for young children [not used in this study].

3. Results

The intervention event was attended by 80 students at School A. See Fig. 1 for the number of responses at each time point.

In the control group at the final data collection point there were 24 responses from each timepoint from the same individuals. Control group composition deviated from protocol wherein control group participants were to be drawn from School B, year 12 and 13. Due to difficulties recruiting participants for the control group, the sampling pool was broadened to include year 13 of School A.

See Fig. 1 for the breakdown of the source of the control group participants.

The characteristics of the participants are shown in Table 1. All but one participant were of white ethnicity. There were approximately three times more participants currently experiencing pain of more than three months in the control group compared to the intervention group.

3.1. Quantitative results

All pain belief outcome measures were improved following the one-day PSE event for the intervention group. This was maintained at the 3 months follow up point for the PBQ psychological beliefs subscale and the COPI-Adult but not the PBQ organic subscale (Table 2). The control group's pain belief outcome measures were slightly reduced from baseline to the post-intervention for PBQ organic and COPI-Adult, but slightly increased by 0.2 points in PBQ Psych. At three months post intervention there was a −0.3 reduction in PBQ Organic and a slight increase in PBQ Psych and COPI-Adult of 0.7 and 0.3 respectively.

There is no established minimally clinically meaningful difference (MCID) for the outcome measures used. However, this can be tentatively estimated as half the baseline SD presented in previous studies (Dworkin et al., 2008). Thus based upon Mankelow et al. (2023) and work with a similar population the MCID for PBQ organic is estimated at 1.8; PBQ psychological at 1.3 and COPI-Adult at 2.4. The change in pain beliefs and knowledge immediately after the intervention, and at three months after the intervention, could therefore be considered clinically meaningful for all three outcome measures.

Table 1
Participant characteristics.

Characteristic	Baseline	
	Intervention	Control
N	30	24
Age (years)	16.6	16.9
*Gender (n)		
Male	19	9
Female	11	15
**Ethnicity		
White	96 %	100 %
Other Ethnic Group	4 %	
Pain		
No pain	50 %	25 %
Previous pain	37 %	34 %
Current pain	13 %	41 %
Areas of pain42 %		
Knee	14 %	38 %
Neck	17 %	17 %
Back	27 %	33 %
Ankle	17 %	13 %
Shoulder	7 %	21 %
Elbow, wrist, hand	7 %	29 %
Other areas of pain, head, legs, hips, feet, torso	17 %	42 %

Legend: * Participants were offered options of male/female/other and prefer not to say.
**Ethnicity options were listed as per the UK Census 2021 but only those options that were selected are reported. Eleven (46 %) participants in the control group reported 2–8 areas of previous or current pain. Seven (23 %) of the intervention group reported 2–5 areas of previous or current pain.

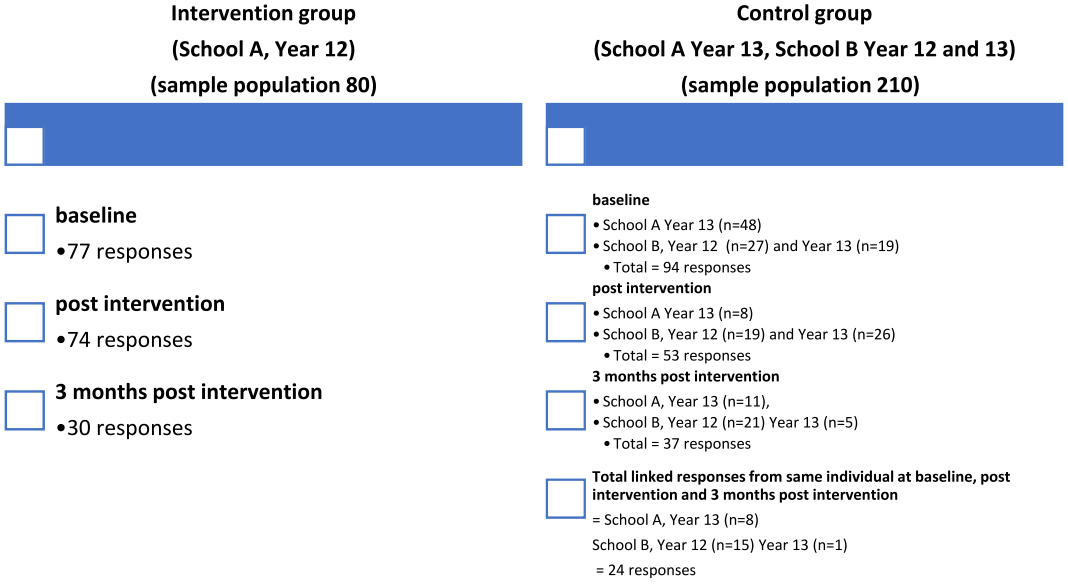

Fig. 1. Breakdown of respondents according to school and year group.

Table 2
Between group point changes in knowledge and beliefs after the PSE day.

Data collection point	PSE Group Mean (SD)	Control Group Mean (SD)	Between Group Mean Difference (95 % CI)	P-value	Effect Size (Cohen d)
Change from Baseline to immediately post intervention					
PBQ Organic	−4.2 (4.8)	−0.2 (1.7)	−4.4 (−6.0, −1.9)	**0.001**	0.6
PBQ Psych	4.8 (4.2)	0.2 (1.6)	4.6 (2.7, 6.4)	**0.001**	0.7
COPI-Adult	8.8 (7.2)	−0.5 (1.6)	9.3 (6.4, 12.4)	**0.001**	0.6
Change from Baseline to* 3 months *post intervention					
PBQ Organic	−2.2 (4.4)	−0.3 (2.5)	−1.9 (−4.0, 0.6)	0.57	0.35
PBQ Psych	3.0 (4.0)	0.7 (3.1)	2.3 (0.3, 4.3)	**0.02**	0.5
COPI-Adult	2.9 (7.5)	0.3 (−3.4)	2.6 (0.7, 6.0)	0.12	0.3

Legend: PBQ – Pain Beliefs Questionnaire; COPI–Adult – Concepts of Pain Inventory-Adult.
Given the exploratory nature of the work P-values and effects sizes should be interpreted cautiously.

Sensitivity analyses were undertaken for each outcome measures using ANCOVA at adjusted for pain prevalence in each group. There was no significant difference between groups for each outcome measure at the time points recorded above.

3.2. Behavioural intention – case vignette responses

Post intervention, participants in the intervention group made more guideline consistent recommendations when imagining themselves with pain with respect to scans, opioids, work, exercise, and bed rest compared to baseline. The recommendations for managing activities of daily living (ADLs) were already well aligned with guidelines before the event and unchanged after the intervention (Table 3). At three months follow up almost all results were still improved compared to baseline point except for opioid use where the responses were slightly less favourable compared from baseline. Intervention group recommendations were more guideline consistent post intervention and at 3 month follow up compared to the control group.

Table 3
Appropriate recommendations before and after a one-day pain science event between groups.

Recommendation	Appropriate recommendation, % (n)	
Scan	PSE	Control
Baseline	20 % (6)	29 %(7)
Immediately Post intervention	70 % (21)	29 % (7)
Three months	43 % (13)	29 % (7)
Opioids		
Baseline	87 % (26)	63 % (15)
Immediately Post intervention	93 % (28)	67 % (16)
Three months	80 % (24)	67 % (16)
Work		
Baseline	70 % (21)	83 % (20)
Immediately Post intervention	83 % (25)	71 % (17)
Three months	83 % (25)	79 % (19)
Exercise		
Baseline	70 % (21)	92 % (22)
Immediately Post intervention	97 % (29)	79 % (19)
Three months	83 % (25)	79 % (19)
ADLs		
Baseline	87 % (26)	96 % (23)
Immediately Post intervention	87 % (26)	79 % (19)
Three months	90 % (27)	67 % (16)
Bed Rest		
Baseline	27 % (8)	25 % (6)
Immediately Post intervention	70 % (21)	13 % (3)
Three months	40 % (12)	21 % (5)

3.3. Qualitative results

There were thirteen participants from the intervention group who consented to interviews (four males, nine females). These were a mixture of individual and group interviews with a maximum of five participants dependent upon what students felt comfortable with. Interviews lasted an average of 20 min (range 6–40 min). Two main areas of experience were explored: 1) participants' understanding of pain and 2) experience of the day.

3.4. Participants' understanding of pain

There were two main themes were constructed from the qualitative data (Fig. 3).

3.4.1. Theme 1: reconceptualisation

All 13 participants showed signs of reconceptualisation of pain drawn from five main subthemes, and four less frequently referred to subthemes as illustrated in Fig. 2. The explanation of what pain was, in a biopsychosocial context, was frequently well articulated by participants. Some key messages from the public health campaign were easily recalled although not all. These included 'medication is not the answer', 'recovery is possible' and 'everything matters when it comes to pain'.

The majority of respondents understood that there is potential to recover from persistent pain, and signs of moving towards a biopsychosocial understanding of pain (reconceptualisation). Some respondents had more nuanced understanding that pain could resolve completely, to pain may or may not persist but recovery of physical activity was still possible. One of the ideas that was frequently reported was that the person with pain should be able to decide what mattered most to them in terms of management and recovery. Furthermore greater empathy for the person with persistent pain was apparent.

Partial reconceptualisation was evident in three individuals who seemed to reconceptualise pain, except with relation to their own persistent pain, which they still considered to be due to tissue impairment. There were still a few individuals who questioned whether pain was real and that there was a need to establish if it was due to 'psychological issues' or an 'unhealthy balance of right diet and stuff'.

3.4.2. Theme 2: increased awareness of persistent pain

A small number of participants reported that they had not considered persistent pain to be a condition before. They may previously have considered it to be a sign of 'weakness' but now viewed it as a common complaint, or went from never considering it before to realising that it was normal.

3.4.3. Participants' experience of the one day PSE event

One main theme was identified from participants' experience of day centring around engagement in PSE events.

3.4.4. Theme 1: engagement in PSE events

Fig. 3 below illustrates the three sub-themes that resulted in the derivation of the overall theme.

3.4.5. Interactive and enjoyable learning

Participants largely found the group-based activities enjoyable, engaging and collaborative. The hands-on and practical activities contributed to the interactive and engaging nature of the event. A minority of respondents requested a shorter lecture by 10 min and some participants felt their group work could be better.

3.4.6. Novelty and uniqueness

The event stood out from traditional educational formats, with participants appreciating the unique approach. Participants felt that the use of illusions and visual aids offered a novel way to communicate complex concepts, enhancing engagement.

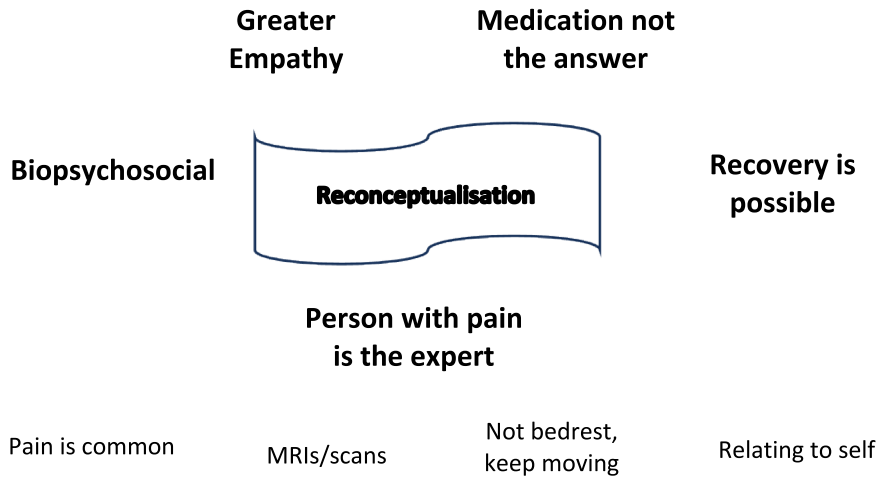

Fig. 2. Theme 1 Reconceptualisation and the subthemes contributing to it
Legend: Bold sub-themes were most commonly expressed, those not in bold were infrequently expressed.

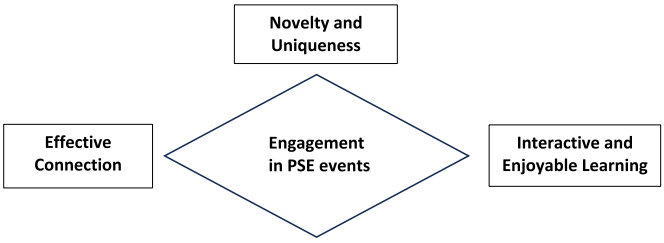

Fig. 3. Subthemes contributing to Engagement in PSE Events.

3.4.7. Effective connection

Metaphors: The use of metaphors to convey pain science concepts, made them more relatable and understandable.

Person with lived experience: The involvement of someone with lived experience of pain added a personal and relatable dimension, deepening engagement.

Interesting: The event maintained interest through a blend of diverse and meaningful content.

4. Discussion

The aim of this study was to conduct a mixed-methods evaluation of the impact of a one-day PSE event delivered within a high school setting. This is the first exploratory mixed-methods, non-randomised controlled UK study examining the impacts of pain knowledge and beliefs following PSE, upon adolescents, as part of a public health campaign. The main finding was that biomedically-focussed beliefs about pain reduced whilst there was an increase in participants' biopsychosocial understanding of pain immediately after PSE. Biopsychosocial pain beliefs, but not organic beliefs were sustained three months after the PSE intervention. The COPI-Adult scale designed to detect changes in pain knowledge and beliefs showed a similar pattern to the PBQ-psychological subscale beliefs. In keeping with the positive shifts in knowledge and beliefs, there were changes in participants' behavioural intentions in line with clinical guidelines specifically with relation to the reduced use of scans and bed rest, and the need to continue to exercise.

In terms of participant understanding, the themes generated were reconceptualisation, partial reconceptualisation and increased awareness of persistent pain. All respondents showed clear signs of reconceptualisation of pain, but a minority also made remarks that suggested their shift in pain understanding was only partial. This was particularly apparent when discussing their personal pain which they believed to be different to the pain of others.

The improvement in beliefs in the intervention group was encouraging. The changes seen from baseline to after the one-day PSE event were similar, albeit slightly greater in this study, than changes seen in our previous uncontrolled study (Mankelow et al., 2023). The findings from the current study are readily comparable with Louw et al. (2018) who found increases of 11 % after a 30 min PSE intervention with middle school children. In our study improvements of 16.5 %, 35.8 % and 26 % in the Organic subscale, psychological subscale and COPI-Adult respectively were made, immediately after the intervention. This dropped to 8 %, 22.3 % and 8.6 % respectively three months after the intervention. Nevertheless, based upon calculated MCIDs proposed in the results sections, these could be considered to be clinically meaningful differences both immediately post intervention and three months post intervention.

There was a marked change in all but one aspect of behavioural intentions as assessed by case vignettes. The participants indicated that they expected someone with pain to more active than they had originally thought, before the intervention, in the event of pain. There was no change in appropriate recommendation for ADLs, however this is likely to be a ceiling effect as responses were already high at baseline, 87 %. Qualitatively, the majority of participants revealed that they found the PSE day engaging and they enjoyed the different elements of information delivery. A few participants suggested improvements to the groupwork and requested a slightly shorter didactic component.

The intervention group had 13 % of participants with chronic pain whilst the control group had 41 %. There may have been selection bias in those who responded to the questionnaire in the control group. However, 37 % of the intervention group had previously had persistent pain compared with 34 % of the control group. This frequency of persistent pain in this study is higher than that reported in children internationally ≤19 years of age at 20.8 (Chambers et al., 2024). Again, this may suggest that there was self-selection bias in both groups.

If the changes in pain beliefs and knowledge can be maintained in the long-term, they may influence the participants' current and future experiences of persistent pain and its associated disability and depression. They may also influence how these individuals respond to pain and thus influence their parents in a bidirectional process of socialising (Davidov et al., 2015).

The PSE intervention content used (as outlined in the supplementary information), was very similar to adult PSE content (Mankelow et al., 2020) and it could serve as the foundation for delivering PSE within the high school curriculum as a means of improving public understanding of pain. It is often said that educational curricula are saturated but there is capacity as evidenced in this study to make pain education a component of general studies teaching such as the School A's LIFE programme (The

Social Market Foundation, 2024). Indeed, in Finland curricula has been altered to educate students about 'fake news' to improve 'critical thinking skills' (Horn and Veermans, 2019) and in this same way students could be encouraged to reconsider prevalent pain misinformation. Additional activities such as groupwork were used to reinforce the information such as the group activity. Future integration of PSE material into biology curriculum could be a sustainable way to implement PSE into schools.

It is envisaged that the findings of this study could be used to further develop methods, materials and delivery styles that would lead to integrating pain education more seamlessly into the curriculum through existing syllabus.

5. Limitations

This non-randomised controlled design means that no claims of cause and effect can be made. Future, fully powered, randomised controlled studies, with longer-term follow up, ideally tracking students into adulthood, are needed to investigate the effectiveness of this intervention.

The control group had an above average level of participants with current pain (41 %) compared to the intervention group (13 %) which may have skewed the outcome measures. Sensitivity analyses did not however suggest that this was the case. Participants with chronic pain might have had an additional interest in the study as it related to them hence their participation. Participants with pain may, though unlikely, have experienced PSE in pain management therapy or they may have strong personal beliefs that may affect the results. In future there could be an exclusion criterion to exclude those who have received PSE previously. There are difficulties with this however as individuals may have received PSE previously but may define it as something other than PSE.

Participants in this study were almost entirely of white ethnicity, however, our previous school-based study found similar results with a majority Asian sample group (Mankelow et al., 2023). This suggests that the PSE can influence pain across different ethnicities and cultures. The study had a high level of attrition. To counter this, future studies should consider strategies to maintain engagement. It may also be a reflection of the timing of the intervention which at three months saw many students' taught sessions diminish as they approached their summer holidays and exam periods and therefore communication about the study became less visible to those students.

Delivering PSE in schools presents logistical challenges, including ensuring full-day attendance, often atypical in this school stage, and managing schools' preferences for inclusive rather than randomised participation. These practical constraints highlight the importance of flexible and tailored study designs that accommodate the realities of the school environment in future studies.

6. Conclusion

A one-day PSE event delivered in a school setting as part of a public health campaign was associated with improved beliefs, knowledge, and behavioural intentions relating to pain in the short and medium term. Qualitatively, students reported limited prior awareness of persistent pain and showed signs of reconceptualisation and partial reconceptualisation. This data highlights the school setting as a potentially important target for pain-based public health interventions to improve public pain beliefs in a manner conducive to reducing pain-related health inequalities. Addressing adolescent pain beliefs may lead to more positive attitudes in adulthood and thus help to improve adults' pain related behaviour in the longer term. It may affect their experiences of pain in the future and health service utilisation. However, controlled trials with longer-term follow-up are needed to investigate the effectiveness of PSE in school curriculum before any firm recommendations can be made.

CRediT authorship contribution statement

J. Mankelow: Project administration, Investigation, Validation, Software, Writing – original draft, Funding acquisition, Data curation, Resources, Methodology, Conceptualization, Writing – review & editing, Supervision, Visualization, Formal analysis. **C.G. Ryan:** Writing – original draft, Project administration, Investigation, Conceptualization, Data curation, Supervision, Methodology, Formal analysis, Writing – review & editing. **N. Skidmore:** Writing – review & editing, Data curation, Investigation. **J. Potter:** Conceptualization, Writing – review & editing. **D. Ravindran:** Conceptualization, Writing – review & editing. **R. Chattle:** Investigation, Writing – review & editing, Data curation. **S. Browne:** Data curation, Writing – review & editing. **S. Suri:** Writing – review & editing, Data curation, Investigation. **A. Graham:** Investigation, Writing – review & editing, Data curation. **J.W. Pate:** Writing – review & editing, Writing – original draft. **R. Newport:** Writing – review & editing, Investigation. **T. Langford:** Writing – review & editing, Data curation, Formal analysis. **D. Martin:** Writing – review & editing.

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Appendix A. Supplementary data

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