International Journal of Sport, Exercise and Health Research 2022; 6(2): 103-110

Research Article

IJSEHR 2022; 6(2): 103-110

www.sportscienceresearch.com
Received: 17-08-2022
Accepted: 16-09-2022
DOI: 10.31254/sportmed.6202

The Pain-Related Fear Scale: The validation of an instrument to measure pain-related fear in younger adults under 45 years of age with obesity

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Abstract

Background: The existence of pain-related fear appears to present an obstacle for health promoting behaviour change, particularly among younger adults with obesity. Measures developed and validated for middle-and-older age groups lack validity in younger adults under 45 years of age. This paper reports on the development and psychometric properties of a new instrument, based on a conceptual framework, to measure pain-related fear in younger adults. **Methods:** A cross sectional survey design was employed. 236 participants aged 18 to 45 years were recruited to participate. Participants completed three existing pain-related fear instruments mapped to a conceptual framework. Exploratory and confirmatory factor analysis identified the dimensions of the new Pain-Related Fear Scale. Construct validity was assessed by comparing scores between physical activity groups; criterion validity by correlation with the Tampa Scale of Kinesiophobia and reliability by Cronbach's alpha. Differences in scores in the Pain-Related Fear Scale were explored across BMI subgroups. **Results:** A four-factor model with 12 items met the most acceptability thresholds for a good fitting model (CFI = 0.983; GFI = 0.953; RMSEA = 0.046; SRMR = 0.0301). Higher mean scores on the Pain-Related Fear Scale were seen among those reporting low activity compared to high activity levels (F= 4.684; P= 0.01). Modest correlation was observed between the new instrument and Tampa Scale of Kinesiophobia (r= 0.508;95% CI= 0.389-0.612). Cronbach's alpha was 0.842. Scores were higher in the obese subgroup compared to the healthy bodyweight group (mean difference= -7.42; CI= -12.26 - -2.58; P= 0.001). **Conclusion:** The Pain-Related Fear Scale is a psychometrically valid measurement of pain-related fear for adults with obesity aged between 18 to 45 years. The instrument can support research relating to barriers to physical activity, and potentially has clinical utility as a screening and outcome measurement.

Keywords: Obesity, Pain-related fear, Fears; Psychometrics, Weight management, Physical activity.

INTRODUCTION

Obesity continues to be a growing public health problem worldwide [1]. The greatest change in body mass index over the past 50 years has occurred amongst young adults (under 45 years of age) [2, 3]. This is particularly concerning given that the occurrence of obesity persists across the life course [4], and because there is then an increased risk of premature morbidity and mortality from obesity related diseases (such as diabetes and cardiovascular disease) [5]. Weight gain in early adulthood has been associated with lifestyle transitional factors which include, leaving the family home, full time employment, increased consumption of fast food, and decreasing physical activity levels [6]. However, despite this, strategies for weight management (which have mainly focused on diet with a secondary focus on promoting physical activity) have infrequently targeted younger adults.

For younger adults with obesity, an increased focus on physical activity has advantages in health benefits beyond weight loss such as improving self-esteem and, independently, reducing the risk of chronic disease (e.g., cardiovascular disease) [1, 4]. However, young adults with obesity find it challenging to meet physical activity guidelines due to a range of barriers [7, 8]. Consensus suggests that psychological concerns are the primary barriers restricting participation [9]. These potential barriers include low mood, lack of motivation, lack of confidence and activity-related fears [10]. One psychological barrier that has received less consideration particularly amongst younger adults, is that of fear [7]. Recent evidence shows that fear-related barriers to activity have largely been explored and observed in middle to older-aged adults (aged over 45 years), with limited literature relating to adults under 45 years of age [7]. However

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the findings of a recent qualitative study by these authors suggested that fear, particularly pain-related fear(s), were a frequent and important barrier to physical activity among younger adults with obesity [11].

Pain-related fear is an established psychological construct, largely referred to in relation to fear avoidance theory (e.g., the Fear Avoidance Model) [12]. The Fear Avoidance Model conceptualises that pain leads to a downward spiral of pain catastrophizing, maladaptive psychological responses (pain-related fear), negative cognitions (depression, disability) and avoidance [12]. Fear is a key factor in the model, highlighting why pain and associated factors (e.g., depression and disability) persist once the pain or injury has subsided [13]. The construct factors of the Fear Avoidance Model have been used in several studies to develop pain-related fear measurement instruments, required to explore this concept in population groups [14].

A systematic review of pain-related fear measurement instruments conducted in 2011 identified several questionnaires, concluding that the Pain Anxiety Symptoms Scale was considered the best available instrument to measure pain-related fear [14]. Although some instruments were deemed valid in older aged adults, the review stated that all existing instruments have limited construct validity because of a lack of conceptual underpinning [14]. In addition, none of the instruments have been developed for, or validated in, younger populations, in whom the construct of pain-related fear may differ. Such an instrument would facilitate an exploration of whether pain-related fear differs across BMI subgroups in younger adults, and if it is a barrier to weight management. [15]. This study reports on the development and validation of a new measurement instrument of pain-related fear in younger adults (18 to 45 years of age) that can be used to explore pain-related fear across BMI subgroups

The objectives of the study were to:

1. Develop a conceptual framework of pain-related fear for younger adults with obesity.
2. Map the conceptual framework to existing pain-related fear measurement instruments.
3. Develop a new instrument underpinned by the conceptual framework.
4. Test the validity and reliability of the new instrument.
5. Explore if the new instrument has potential discriminant utility between different BMI subgroups.

MATERIALS AND METHODS

The first step was to elucidate the construct of pain-related fear as experienced by younger adults with obesity. The qualitative study exploring activity related fears in obese younger adults (undertaken by Hamer et al), highlighted the underpinning factors specifically for pain-related fear (11). Six factors were identified including:

(1) experienced pain; (2) catastrophisations of pain; (3) disability; (4) fear; (5) activity avoidance/ escape and (6) physiological responses/ guarded movements

Examples of supporting quotes are provided in table 1.

Table 1: Evidence of construct factors for pain-related fear from existing literature

Construct factors	Supporting quotes (Hamer *et al.,* 2021a)
1. Experienced pain	'My back gives me that much pain that even when I'm on my tablets and stuff like that, I still can't pick up my daughter, I still find it hard doing the simplest of tasks' (Participant 9).
2. Catastrophisations of pain	'I think about it (pain) as soon as I'm approaching it (exercise machine) and I'm thinking right, do I, what do I do, I'm like do I do it.' (Participant 2).
3. Disability	'I don't want to be that person that's just sort of in a wheelchair just sort of unable to move any of the time' (Participant 9).
4. Fear	'I'm always scared of getting hurt, I always avoid it (physical activity)' (Participant 3).
5. Activity avoidance/ escape	'If I had that fear and I was going to go to the gym or someone asked me to go or asked me if a want to go for a run and my legs were in pain there's no chance, I would just stay inside' (Participant 3).
6. Physiological responses/ guarded movements	'No jumping ever, no star jumps, no jumping on boxes anything like that' (Participant 6).

This conceptual framework suggested that existing instruments (alone) did not cover all the existing factors for the construct of pain-related fear in younger adults with obesity (14), but that it may be mapped onto the domains and items of a combination of existing validated questionnaires relating to pain and/or pain-related fears. Therefore, a mapping of the construct factors onto existing pain-related fear instruments was undertaken; this confirmed that none measured all six factors but combination of three had relevant domains to provide a strong basis for the development of a measurement instrument:

The Pain Anxiety Symptoms Scale Short Form 20 comprises of four subscales: Cognitive, avoidance, fear, and physiological anxiety [15]. The construct factors of fear, avoidance, physiological responses and catastrophisations of pain were mapped to the Pain Anxiety Symptoms Scale Short Form 20 subscales [15]. The scale is scored with 20 items, each item has a score from zero to five which five is 'always' and zero is 'never'. The range of subscales scores are from zero to 25. The total score is calculated by adding up the subscale scores with a range between zero to 100 [15].

The Pain Disability Index is a measurement instrument of perceived disability comprising two subscales; obligatory disability (activities required to maintain life) and discretionary disability (voluntary activities). The construct factor of perceived disability was mapped to the Pain Disability Index subscales. The Pain Disability Index is scored with seven items, each item has a score from zero to 10, where 10 is 'worst disability' and zero is 'no disability'. The range of subscales scores are from zero to 50 for discretionary subscale and zero to 20 for the obligatory subscale. The total Pain Disability Index score can range between zero to 70. This instrument is particularly relevant given its items relate to several contexts of physical activity [16, 17].

The Pain Numeric Rating Scale is unidimensional in its factor of pain with just one item [18, 19]. The construct factor of experienced pain was mapped to the Pain Numeric Rating Scale factor. The item has a score from zero to ten which ten is 'worst pain possible' and zero is 'none'.

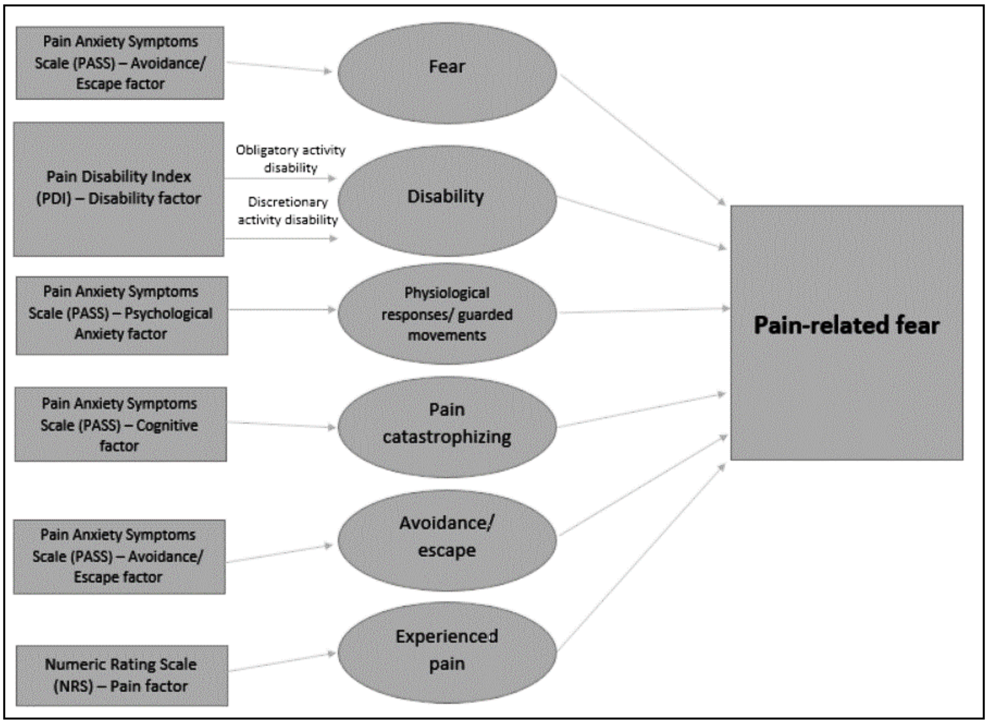

Figure 1: A mapping of constructs from existing instruments to the construct of pain-related fear identified by Hamer *et al.,* (2021)

In combining the Pain Anxiety Symptoms Scale -20, Pain Disability Index, and Numeric Rating Scale, resulted in some overlap in constructs between the instruments. Because of this, it was expected that there would be redundant items and items that did not map well. Therefore, the development of a new instrument from a combination of these instruments required domain discrimination and item reduction before testing of psychometric properties.

Study design

A cross-sectional survey was undertaken. Participants aged between 18 to 45 years were recruited from universities, leisure facilities and several weight management groups, primarily in the North West, England. Recruitment of participants was encouraged through the distribution of posters and leaflets, emails via university and weight management organisation mailing lists and through social media posts. Participants who suffered problems that may have affected their balance or ability to take part in physical activity were excluded. Participants completed sociodemographic and anthropometric information on age, gender, height, weight, employment status, and any functional limitations and/ or balance problems that may affect physical activity. Participants completed a set of measurement instruments.

The three measurement instruments covering the construct factors for pain related fear were: Pain Anxiety Symptoms Scale Short Form 20, Pain Disability Index and the Pain Numeric Rating Scale; a measure employed as the 'gold standard' to establish criterion validity of the new measurement instrument - Tampa Scale of Kinesiophobia, and a measurement instrument employed to establish construct validity through hypothesis testing (known group's difference method) - the International Physical Activity Questionnaire- Last 7 days Short form [20].

Ethics

Ethical approval was obtained from (Removed for Blind Review) research ethics committee and adhered to the University's code of conduct, which included participants right of withdrawal (Removed for Blind Review). All participants received written information on the studies. Written informed consent was implied through questionnaire completion.

Data analysis

Statistical analysis was conducted using the Statistical Package for the Social Sciences with Amos software (SPSS, IBM version 25.0). Where appropriate, 95% Confidence Intervals were estimated around estimates of effect and a P-value <0.05 was considered statistically significant. There were 54 missing values identified within the dataset (did not exceed more than 3% in any one item variable). Missing values were imputed using a regression (multiple imputation) method, because other variables (age, gender, body mass index, occupation, pain-related fear scores and physical activity scores) were available as reliable predictors [21]. Values from 50 cycles of imputation were pooled, and the estimated mean value used.

Exploratory factor analysis was conducted using the data from all participants to group items from the combination of instruments into meaningful dimensions [22]. This process also served item reduction [22]. Analysis was conducted using the dimension reduction factor in SPSS. The 28 items (with six pre-established factors) from the Pain Anxiety Symptoms Scale Short Form 20, Pain Disability Index and Pain Numeric Rating Scale were included as the variables. In the first instance, factors were only retained if they had an eigenvalue >1 [22]. Orthogonal rotation (varimax feature) was employed to create a component matrix [23]. A minimum loading of 0.5 was employed as an adequate threshold for item factor loading, deemed appropriate for a measurement in medicine [22, 24]. Items were deleted if they did not adequately load (scores below 0.5) onto one factor or loaded substantially (>0.5) on more than one factor [22]. Four items were deleted during exploratory factor analysis leaving 24 items that loaded within acceptable parameters on four factors.

Following exploratory analysis, confirmatory factor analysis was employed to test the model fit of several four factor models (established following exploratory factor analysis) to determine the best fitting model [22, 25]. Initially, factors were only retained if they produce an eigenvalue >1. Different models were tested to assess the model fit using the thresholds proposed in De Vet *et al.,* [22]; comparative fit index >0.95; goodness of fit index >0.95; adjusted goodness of fit index >0.9; P Value < 0.05; root means square error of approximation <0.06; Chi squared <0.05 [22, 26]. Following its development, the new instrument was named the Pain-Related Fear Scale.

The next procedure was to measure the psychometric properties using methods of construct validity, criterion validity and reliability (Cronbach's alpha).

Construct validity of the Pain-Related Fear Scale was investigated using the known groups difference method, the hypothesis being that increased pain-related fear scores would be associated with lower physical activity levels. The International Physical Activity Questionnaire- Last 7 days Short form data was categorised into high, moderate, and low activity groups using the International Physical Activity Questionnaire research committee protocol guidelines (2005) [22]. The relationship between Pain-Related Fear Scale scores and physical activity levels were explored using analysis of variance (ANOVA), with pairwise testing using a Bonferroni test [22].

Criterion validity was investigated through correlation of scores between the new instrument and the Tampa Scale of Kinesiophobia, as the 'gold' standard. The Tampa Scale of Kinesiophobia has two validated construct factor dimensions [27]. One factor dimension is described as harm/ somatic focus and the second factor is fear avoidance (which incorporates activity avoidance and fear of movement/ injury). The fear avoidance factor dimension of the Tampa Scale of Kinesiophobia was used in comparison with the fear avoidance dimensions of the Pain Anxiety Symptoms Scale Short Form 20 to establish criterion validity. Moderate to strong correlations were initially expected between the fear and avoidance subscales of the Pain Anxiety Symptoms Scale Short Form 20 and Tampa Scale of Kinesiophobia instruments. The remaining dimensions of the Tampa Scale of Kinesiophobia and Pain Anxiety Symptoms Scale Short Form 20 were considered for analysis but were difficult to compare because the construct dimensions lack adequate descriptions from a conceptual model. The Tampa Scale of Kinesiophobia was chosen because of its comparable factors of fear avoidance with the factors of fear and its use within physical activity [27]. A correlation of at least 0.3 was considered satisfactory for criterion validity [22]. Cronbach's alpha ≥ 0.7 was employed to determine adequate reliability of the new instrument [22].

The instrument had been designed to explore pain related fears across BMI groups with the hypothesis that they were greater in obese young adults. Therefore, the potential discriminant utility of the new instrument as assessed by comparing scores across healthy weight (body mass index <25kg/m^2), overweight (body mass index 25 to 29.9kg/m^2) and obese (body mass index > 30kg/m^2) subgroups.

Sample

Sample size recommendations for exploratory and confirmatory factor analysis are a minimum of 4 to 10 participants per item [22]. This study was designed to test factor models based upon three existing instruments that equated to 28 items. Working on the assumption of 8 participants per item, the number of participants completing the questionnaires required was 224. To account for a potential loss of data due to missing values, the sample size was inflated by a further 5% and the number needed to recruit was estimated to be 235. This sample size was sufficient for known groups difference of body mass index groups, and correlation predicted on 0.4 with a lower confidence interval of at least 0.3 [22].

RESULTS

A total of 236 participant responses were received. Most participants were under 25 years old (n= 171, 72%) and female (n=168, 71%). Participants' body mass index ranged from 16.2 to 42.4 kg/m^2, with a sample mean of 26.6kg/m^2 (SD 5.58; 95% CI 25.8 to 27.3) of which 71 (30%) were overweight, 64 were obese (27%), 93 were healthy weight (40%), and eight (3%) were underweight. Most participants had high or moderate levels of activity, but 53 participants (22%) had low levels (Table 2). Of the participants in the obese category, 19 had low levels of activity, 28 had moderate levels and 17 had high levels of activity.

Table 2: Participant characteristics of quantitative phase

	Category	n	(%)
Age	18 to 21 years	131	(55)
	22 to 25 years	40	(17)
	26 to 29 years	20	(9)
	30 to 33 years	9	(4)
	34 to 37 years	15	(6)
	38 to 41 years	15	(6)
	42 to 45 years	6	(3)
Gender	Male	68	(29)
	Female	168	(71)
Body Mass Index	Underweight (below 18.5kg/m^2)	8	(3)
	Healthy weight (18.5–24.9 kg/m^2)	93	(40)
	Overweight (25.0–29.9kg/m^2)	71	(30)
	Obese (greater than 30kg/m^2)	64	(27)
Physical activity levels	Low (who not meet criteria for categories 2 or 3)	53	(22)
	Moderate (3 or more days of vigorous-intensity activity of at least 20 minutes per day)	87	(37)
	High (vigorous-intensity activity on at least 3 days achieving a minimum total physical activity of at least 1500 MET-minutes/week)	96	(41)

The Pain Anxiety Symptoms Scale Short Form 20, Pain Disability Index and the Pain Numeric Rating Scale had 28 variables totalling 100% of explained variances. However, five factors (explaining 67.37% of the variance) had an eigenvalue >1 and were analysed (see Table 3 and figure 2) [22]. The rotated components matrix identified how each item loaded on one of these five factors [28]. Using the threshold of 0.5, seven items loaded substantially on factor one, seven items loaded substantially on factor two, five items loaded substantially on factor three, four items loaded substantially on factor four and four items loaded substantially on factor five. Item six which asked participants 'I will stop any activity as soon as I sense pain coming on' and item 28 which asked participants to 'rate their pain experience from one to ten', were deleted because they did not adequately load on any factor [22]. Item five (related to a broader worry of pain) was deleted in line with the guidance of De Vet *et al.,* [22] because it loaded on two factors (at 0.544 on factor two and 0.568 on factor three).

Table 3: Output factor analysis of PASS-20, PDI and NRS 28 items

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	10.017	35.777	35.777
2	4.488	16.028	51.805
3	1.791	6.396	58.200
4	1.538	5.494	63.695
5	1.031	3.682	67.377
6	0.901	3.218	70.594
7	0.818	2.920	73.514
8	0.753	2.690	76.204
9	0.627	2.238	78.442
10	0.587	2.095	80.537

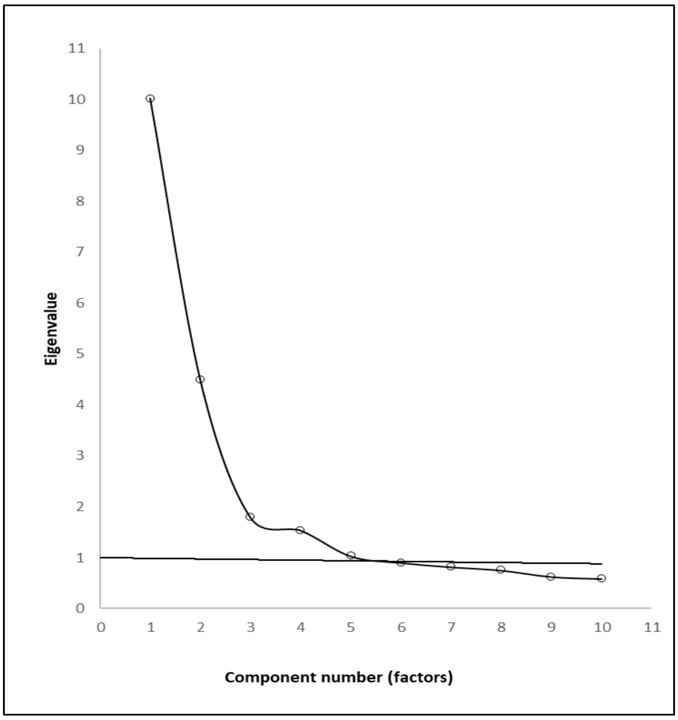

Figure 2: Scree plot of eigenvalues from EFA of PASS-20, PDI and NRS 28 items

Table 4: Rotated component matrix - distribution of item loading on the four factors established from the EFA

Factor 1 – (Perceived disability)	Factor 2 - (Fear avoidance)	Factor 3 - (Pain catastrophizing)	Factor 4 – (Physiological responses)
Item 21 (0.878) (*PDI Q1*)	Item 7 (0.526) (*PASS-20 Q7*)	Item 1 (0.777) (*PASS-20 Q1*)	Item 17 (0.697) (*PASS-20 Q17*)
Item 22 (0.858) (*PDI Q2*)	Item 9 (0.510) (*PASS-20 Q9*)	Item 2 (0.830) (*PASS-20 Q2*)	Item 18 (0.820) (*PASS-20 Q18*)
Item 23 (0.885) (*PDI Q3*)	Item 10 (0.549) (*PASS-20 Q10*)	Item 3 (0.746) (*PASS-20 Q3*)	Item 19 (0.816) (*PASS-20 Q19*)
Item 24 (0.876) (*PDI Q4*)	Item 11 (0.681) (*PASS-20 Q11*)	Item 4 (0.789) (*PASS-20 Q4*)	Item 20 (0.680) (*PASS-20 Q20*)
Item 25 (0.806) (*PDI Q5*)	Item 12 (0.717) (*PASS-20 Q12*)		
Item 26 (0.877) (*PDI Q6*)	Item 13 (0.569) (*PASS-20 Q13*)		
Item 27 (0.851) (*PDI Q7*)	Item 14 (0.795) (*PASS-20 Q14*)		
	Item 15 (0.801) (*PASS-20 Q15*)		
	Item 16 (0.678) (*PASS-20 Q16*)		

Following the deletion of these items, the factor analysis identified four factors with eigenvalues >1. Factor five was dropped (item related to experienced pain) because it did not have an eigenvalue >1. With the four remaining factors, analysis revealed that an item which asked participants 'As soon as pain comes on, I take medication to reduce it' did not load adequately onto any of the factors and so was deleted. This process left 24 items that loaded within acceptable parameters on one of the four factors with an eigenvalue greater than one. Once the instrument items had been grouped into factors, each factor was examined to establish a common theme. Based on the researcher's interpretations and factors identified by existing literature, factors were named 1) perceived disability, 2) fear avoidance, 3) pain catastrophizing and 4) physiological responses. These represented the content of the items within each factor and the overall construct factor of pain-related fear (Table 4).

The exploratory factor analysis revealed that together the items fit best within a 24 item, four-factor model compared to a 28 item, five-factor model. Factors varied in the number of items, however they each exceeded the acceptable minimum of three items per dimension [22].

Confirmatory factor analysis was employed to examine the structural validity of the new instrument. Analysis revealed that the four-factor model with 24 items did not meet the thresholds of comparative fit index, goodness of fit index, adjusted goodness of fit index, root means square error of approximation that represent adequate model fit indices [22]. It was established that several of the items were not fitting adequately within their factor dimensions. The items with the highest standardised residual covariance's above the acceptability threshold of 0.5 were chosen for deletion because they indicated discrepancies between the estimated and proposed models [22, 26]. Items were deleted one by one until one or more of comparative fit index, goodness of fit index, adjusted goodness of fit index, root means square error of approximation or Chi squared thresholds (for adequate model fit) had been met. Following the deletion of several items, a four-factor model containing 15 of the original 24 items was established as comparative fit index met the acceptability threshold exceeding 0.95. However, further item reduction was conducted because comparative fit index, adjusted goodness of fit index and root means square error of approximation remained outside of acceptable thresholds for good model fit.

Following the deletion of three further items, a four-factor model with 12 items was established that met most acceptability thresholds for a good fitting model (with a comparative fit index of 0.983, goodness of fit index of 0.953 and root means square error of approximation of 0.046 [26]. An acceptable threshold for chi-square was not achieved with the four-factor model. However, this was somewhat expected given that the chi-squared statistic nearly always rejects a model when large sample sizes are included in the analysis [29]. For this reason, because the alternative indices of comparative fit index, goodness of fit index, adjusted goodness of fit index and root means square error of approximation were observed as indicating a good model fit, the confirmatory factor analysis was concluded with the 12 item four factor model (seen in table 5) [26]. The standardised residual covariance for the 12-item model suggested that further items could be deleted for better model fit. However, the decision was made to cease item reduction because of guidelines that advocates for a minimum of three items per factor dimension [22]. This made up the Pain-Related Fear Scale (see figure 3, confirmatory factor analysis graph by AMOS program).

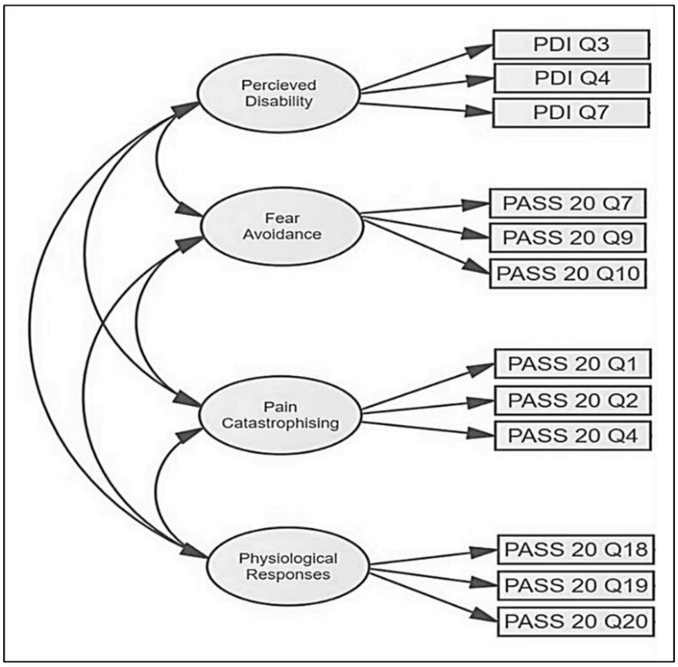

Figure 3: Confirmatory factor analysis graph by AMOS program

To support the validity of Pain-Related Fear Scale instrument, the four-factor model was compared to a model derived from the original 28 items using a six-factor model that represented the original sub dimensions of the combined instruments. Analysis showed that the six-factor model did not have adequate model fit indices that met the proposed thresholds [22, 29]

Table 5: Four-factor model comprising 12 items (PRFS)

Item(s)	**Factor(s)**
1. I can't think straight when in pain	(1) Pain Catastrophising [a]
2. During painful episodes it is difficult for me to think of anything besides the pain	
3. I find it hard to concentrate when I hurt	
4. I will stop any activity as soon as I sense pain coming on	(2) Fear Avoidance[a]
5. I avoid important activities when I hurt	
6. I try to avoid activities that cause pain	
7. When I sense pain, I feel dizzy or faint	(3) Physiological Responses [a]
8. Pain makes me nauseous.	
9. I find it difficult to calm my body down after periods of pain.	
10. I typically experience disability during social activity (activities which involve friends and acquaintances)	(4) Perceived Disability [a]
11. I typically experience disability during occupation (activities that are part of or directly related to one's job)	
12. I typically experience disability during life-support activities (activities such as eating, sleeping, and breathing)	

[a] Factors 1-3 includes items from the PASS-20; factor 4 includes items from the PDI.

The mean pain-related fear score (measured by the Pain-Related Fear Scale) of the sample was 23.6 (SD 11.81). The mean differences within the Pain-Related Fear Scale instrument were significant between the low activity group compared to the high activity group (Mean difference= 5.6, CI= 0.82 – 10.42, P= 0.015). However, mean Pain-Related Fear Scale scores were not statistically significant between low to moderate activity groups and moderate to high activity groups (Mean difference= -1.77, CI= -6.67 – 3.10, P= 1.00). There was a moderately strong association between the Pain-Related Fear Scale and the Tampa Scale of Kinesiophobia (*r*= 0.508, P< 0.001, 95% CI lower bound= 0.389, upper bound= 0.612).

The Pain-Related Fear Scale had a Cronbach's alpha score of 0.842 which is deemed to be good reliability (internal consistency) for a measurement instrument [22]. Item total statistics were analysed and established that Cronbach's alpha scores could not be improved through further item reduction (see Table 6).

Table 6: Item total statistics for the PRFS

	Corrected Item-Total Correlation	**Squared Multiple Correlation**	**Cronbach's Alpha if Item Deleted**
PRFS item 1	0.565	0.586	0.827
PRFS item 2	0.597	0.637	0.826
PRFS item 3	0.557	0.556	0.828
PRFS item 4	0.463	0.375	0.833
PRFS item 5	0.544	0.491	0.828
PRFS item 6	0.475	0.397	0.832
PRFS item 7	0.488	0.592	0.831
PRFS item 8	0.507	0.596	0.830
PRFS item 9	0.562	0.489	0.827
PRFS item 10	0.540	0.692	0.829
PRFS item 11	0.541	0.640	0.832
PRFS item 12	0.484	0.579	0.834

The mean Pain-Related Fear Scale score of participants in the obese category was 29.8 (SD 12.01), compared to means scores of 22.3 (SD 11.08) in the healthy weight, and 20.3 (SD 10.80) in the overweight category. The mean differences within the Pain-Related Fear Scale instrument were a significant between the obese body mass index group compared to the healthy weight body mass index group (Mean difference= -7.42, CI= -12.26 - -2.58, P= 0.001), and the obese body mass index group compared to the overweight body mass index group (Mean difference= 9.46, CI= 4.31 – 14.60, P= 0.001).

DISCUSSION

This study provides a theoretical foundation for pain-related fear in younger adults with obesity in that it identified and validated four construct factors (perceived disability, fear avoidance, pain catastrophizing and physiological responses). These construct factors encompass the multidimensional construct of pain-related fear as perceived by adults with obesity aged between 18 to 45 years. The new Pain-Related Fear Scale captures these construct factors and provides a more valid measure of pain-related fear in this population. This new instrument showed good evidence to suggest it may be a superior alternative to pre-existing instruments; supported by four key points: Firstly, the new instrument was better correlated with the Tampa Scale of Kinesiophobia compared to alternates such as the Pain Anxiety Symptoms Scale Short Form 20 (*r*= .508 compared to *r*= .500) [22]. The strength of this association exceeded 0.4 and a 95% lower bound confidence interval greater than 0.3 and so met the acceptability level of criterion validity between two instruments that propose to measure similar constructs (fears relating to pain) [22]. This provided evidence that the new instrument measured similar constructs relating to fear avoidance and catastrophisations of pain. Secondly, analysis showed significant differences in mean scores of pain-related fears between younger adults who participated in low levels of activity groups compared to those who participated in high levels of activity (P= 0.015). The significant differences found between these groups are consistent with research in older adults but are unique in that they provide construct validity for younger adults [30-32]. Thirdly, the instrument has 12 items which substantially reduces the burden on participants compared to longer existing instruments [33, 34]. This is beneficial in that it can increase response rates and lessens administration time [35]. Finally, its main advantage in that is has been developed with conceptual underpinning obtained from literature that provides a detailed definition of the construct and is relevant to the target population [11]. This is unlike all previous instruments that have failed to identify a strong conceptual underpinning for the development of a construct model [14].

After applying the new instrument, it showed that younger adults with obesity experience pain-related fears that provoke activity avoidance. These findings are consistent with the fear avoidance beliefs of middle and older aged adults [31, 32]. The relationships found within the data align with several of the sequential and dynamic relationships of the theoretical Fear Avoidance Model [13]. However, younger adult's (who are obese) conceptualisations of pain-related fear are not wholly representative all factors of the Fear Avoidance Model [12]. This study also provides evidence that fearful cognitions likely heighten perceptions of disability which increase the risk of inactivity. This is key because beliefs that relate to capability and efficacy (perceived disability) are key factors required by well-known behaviour modification frameworks for health behaviour change (such as The Behaviour Change Wheel) [36].

Alongside associations with activity levels, the current study found a significant increase in fears reported by younger adults with obesity compared with younger overweight and healthy weight adults. This is consistent with several studies that found significantly greater pain-related fears in older patients with obesity, compared to older non-obese patients [30]. To the best of the authors knowledge, this is the first study to identify this in a younger adult non-clinical sample. This provides some rationale as to why younger adults with obesity may remain inactive for long periods, unable to enact health promoting behaviour change [36].

A significant strength of the present study is that it adhered to guidelines set by De Vet *et al.,* [22] on how to develop a measurement instrument for psychometric assessment. These guidelines included the validation of the new instrument using criterion validity, construct validity, factor analysis and internal consistency. The study recruited sufficient participants to achieve statistical significance for important outcomes and thresholds, which strengthens confidence in the results. A limitation of this study, however, was the non-random convenience method of sampling, consequently, there is some uncertainty that the sample is representative of the national population of adults aged 18 to 45 years. That said, this method of sampling provided a sample large enough for complex statistical analysis with adequate power to conduct factor analysis and validity testing, stratifying by physical activity and body mass index groups [22]. A further limitation existed with the reliance upon self-reported participant characteristics and instrument scores [37]. It is possible that instrument scores or participant characteristics may be over or underestimated which could have had an impact on interpretations of the associations between variables (such as body mass index, physical activity levels and fear related barriers) and group mean data [38]. This study mitigated some of these concerns within the analysis by employing body mass index and physical activity ordinal categories (e.g., healthy, overweight, obese, and low, moderate, high etc.), alternate to continuous numerical variables (e.g., kilograms/ metre squared and metabolic equivalents). This decision was guided by previous research that suggests the over or underestimation of self-reported weight and physical activity levels do not have a significant impact on the accurate identification of body mass index or physical activity classifications in younger adults (e.g., being classified as overweight or obese, low or high activity levels) [39, 40].

Although there is evidence of validity, further research is required to strengthen evidence of reliability for the measurement properties of the new Pain-Related Fear Scale [41]. The guidance outlined by Consensus-Based Standards for the Selection of Health Status Measurement Instruments states that instruments require an evaluation of test re-test reliability, measurement error rate and analysis of interpretability [22, 41]. Research is also needed to establish cut off points to classify the severity of pain-related fear within the new instrument [22]. Once established, researchers and practitioners may use the instrument to measure pain-related fear to improve understanding of individual severity in younger adults with obesity aged between 18 to 45 years.

CONCLUSION

To conclude, the new Pain-Related Fear Scale developed in this study is a valid measure of pain-related fear for younger adults with obesity aged between 18 to 45 years. The instrument can support research relating to barriers to physical activity, and potentially has clinical utility as a screening and outcome measurement. The Pain-Related Fear Scale is important because existing measurement instruments of pain-related fear have not been validated in younger adults, and they do not represent all the key construct factors required for measurement [14]. Conceptually, these findings suggest that pain-related fear is a multidimensional construct which encompasses factors of perceived disability, fear avoidance, pain catastrophizing and physiological responses. This construct appears to be a particular concern for younger adults as this study suggests it could be associated with a greater risk of inactivity. The existence of pain-related fear appears to present an obstacle for health promoting behaviour change, particularly among younger adults with obesity. This study goes some way in confirming and quantifying fear as a risk factor for inactivity in younger adults with obesity.

Acknowledgements

The authors sincerely thank all the participants who voluntarily gave up their time to contribute to the research. Without their participation, the study would not have been possible.

Funding

The write up of this report was partly research funded by the National Institute for Health Research Applied Research Collaboration Northwest Coast (ARC NWC). The views expressed in this publication are those of the author(s) and not necessarily those of the National Institute for Health Research, the NHS or the Department of Health and Social Care.

Conflict of Interest

The author reports no conflicts of interest in this work

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