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Psychological factors not strength deficits are associated with severity of gluteal tendinopathy: a cross-sectional study

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Conflicts of interest

None declared

Significance

Patients with severe gluteal tendinopathy exhibit greater psychological distress, poorer quality of life, and greater waist girth and BMI when compared to less severe cases. This implies that clinicians ought to consider psychological factors in the management of more severe gluteal tendinopathy.

Abstract

Background: Gluteal tendinopathy is the most common lower limb tendinopathy presenting to general practice. It has a high prevalence among middle-aged females and impacts on daily activities, work participation and quality of life. The aim was to compare physical and psychological characteristics between subgroups of severity of pain and disability.
Methods: A multi-centre cross-sectional cohort of 204 participants (mean age 55 years, 82% female) who had a clinical diagnosis of gluteal tendinopathy with MRI confirmation were assessed. A range of physical and psychosocial characteristics were recorded. Pain and disability was measured with the VISA-G Questionnaire. A cluster analysis was used to identify mild, moderate and severe subgroups based on total VISA-G scores. Between group differences were then evaluated with a MANCOVA, including sex and study site as covariates, followed by a Bonferroni post-hoc test. Significance was set at 0.05.
Results: There were significantly higher pain catastrophizing and depression scores in the more severe subgroups. Lower pain self-efficacy scores were found in the severe group compared to the moderate and mild groups. Greater waist girth and body mass index, lower activity levels and poorer quality of life was reported in the severe group compared to the mild group. Hip abductor muscle strength and hip circumference did not differ between subgroups of severity.
Conclusions: Individuals with severe gluteal tendinopathy present with psychological distress, poorer quality of life, greater BMI and waist girth. Given these features, the consideration of psychological factors in more severe patients may be important to optimise patient outcomes and reduce health care utilisation.

Introduction

Tendinopathy of the gluteus medius and minimus muscles is clinically characterized by lateral hip pain and tenderness on palpation of the greater trochanter (Grimaldi et al., 2015; Kong et al., 2007). Levels of pain, disability and quality of life amongst individuals with gluteal tendinopathy are commensurate with that of end stage hip osteoarthritis and there are negative effects of gluteal tendinopathy on physical and functional activities and fulltime employment (Fearon et al., 2017; Fearon et al., 2014). A high level of pain and disability is the most consistent prognostic indicator of poor outcome in other musculoskeletal injuries (Dunn et al., 2011; Mallen et al., 2007), including tendinopathy at the lateral elbow (Coombes et al., 2014; Haahr and Andersen 2003; Smidt et al., 2006). It is hypothesised that individuals who have greater levels of pain and disability present differently compared with less severe cases. For example previous evidence in lateral elbow tendinopathy reveals greater sensitivity to cold stimuli, poorer quality of life and more prevalent sleep disturbance in individuals with more severe pain and disability (Coombes 2012).

Although physical impairments and increased BMI have been identified in individuals with gluteal tendinopathy compared to health controls, little is known about differences between subgroups based on severity of pain and disability. Compared to healthy controls, large deficits in bilateral hip abductor muscle strength are reported in gluteal tendinopathy (Allison et al., 2017; Fearon et al., 2017; Ganderton et al., 2017), alongside differences in muscle activity (Allison et al., 2017; Ganderton et al., 2017), kinetics and kinematics (Allison et al., 2016a; Allison et al., 2016b; Allison et al., 2016c). The association between gluteal tendinopathy and anthropometric features such as body mass index (BMI), waist- and hip girth show somewhat contradictory evidence (Allison et al., 2015; Fearon et al., 2012; Flack et al., 2012; Ganderton et al., 2017).

Evidence of involvement of psychological features of persistent musculoskeletal pain is growing, and has been associated with both pain (Carroll et al., 2004) and disability (Das De et al., 2013; de Moraes Vieira et al., 2014; Grotle et al., 2010). In tendinopathies, pain catastrophizing was found to be associated with upper limb rotator cuff tendinopathy (Kromer et al., 2014), whereas the presence of anxiety (Alizadehkhaiyat et al., 2007; Garnevall et al., 2013) and depression (Alizadehkhaiyat et al., 2007) were found to be associated with lateral elbow tendinopathy. A recent qualitative study of individuals with persistent Achilles tendinopathy reported an association with psychological burden during daily life activities and high valued activities (Mc Auliffe et al., 2017). To our knowledge, no evidence of psychological factors in gluteal tendinopathy exists.

The aim of this study was to examine the differences in physical and psychological factors in participants with gluteal tendinopathy of different levels of pain and disability.

Methods

This cross-sectional study was performed using baseline data collected between March 2013 and September 2015 for a prospective randomized clinical trial conducted in a university setting in Brisbane and Melbourne, Australia (Mellor et al., 2016). Ethical approval was obtained from the Human Research Ethics Committee of the University of Queensland in

October, 2012 (HREC No. 2012000930) and the Behavioural and Social Sciences Human Ethics Sub-Committee of the University of Melbourne (Ethics ID 1238598). All participants provided written informed consent.

Participants

Volunteers were recruited from the community by advertisements in University News, social media and local newspapers. Inclusion criteria were: aged between 35 and 70 years, experiencing lateral hip pain for at least three months with an average intensity of ≥4/10 on an 11-point pain numeric rating scale (PNRS) on most days (where 0 is no pain and 10 is worst pain imaginable) (Mellor et al., 2016). To be eligible, volunteers needed to experience pain on direct palpation of the gluteal tendon insertions on the greater trochanter and test positive (reproduction of trochanteric pain) on at least one of six clinical tests (FABER test, FADER test, isometric muscle contraction in FADER position, adduction test, isometric muscle contraction in adduction position and single leg stance on affected leg for 30 seconds) (Mellor et al., 2016). Those who met these clinical criteria underwent magnetic resonance imaging (MRI) to confirm the diagnosis of gluteal tendinopathy. A positive diagnosis of tendinopathy on MRI was defined as an intra-tendinous increase in signal intensity on T2-weighted images (Blankenbaker et al., 2008; Mellor et al., 2016). An X-ray (AP and Lateral) was required to grade osteoarthritis severity using the Kellgren-Lawrence Scale (Kellgren and Lawrence 1957). Participants with a Kellgren-Lawrence score of greater than 2 and/or pain on the hip flexion-adduction (hip quadrant) test that was greater than 5/10 on the PNRS were excluded from the study.

Pain and disability

The severity of gluteal tendinopathy was determined by scores from the VISA-G questionnaire, a self-reported, condition-specific tool (Fearon et al., 2015). The questionnaire consists of 8 items, addressing current pain and during exercise and function. Scores range from 0 to 100, with higher scores indicating less pain and better function. The VISA-G demonstrates good test-retest reliability (ICC 0.827; 95% CI 0.638-0.923), internal consistency (Cronbach's alpha 0.809; 95% CI 0.709-0.934) and construct validity, compared to the Harris Hip Score and the Oswestry Disability Index (Fearon et al., 2015). The researchers who performed the anthropometric and strength testing were not aware of the patient reported outcomes.

Average pain and worst pain ratings over the previous week were measured by the PNRS, where 0 = no pain at all and 10 = the worst pain imaginable.

Psychological factors

Pain catastrophizing scale (PCS)

This is a 13-item self-report scale that measures pain catastrophizing and has been shown to be valid and reliable (Sullivan and Bishop 1995). Participants are asked to reflect on past painful experiences and to indicate the degree to which they experienced each of 13 thoughts or feelings when experiencing pain, on a 5-point Likert scale (0 = not at all, 4 = all the time). The Pain Catastrophizing Scale is composed of three subscale scores assessing rumination, magnification and helplessness. Total scores range from 0 to 52, where higher scores reflect higher levels of pain catastrophizing (Sullivan and Bishop 1995).

Pain self-efficacy questionnaire (PSEQ)
This questionnaire measures one's beliefs about whether they can engage in activities and enjoy life despite experiencing pain (Nicholas 2007). It has been shown to be a valid and reliable measure (Tonkin 2008). It is a 10-item questionnaire covering a range of functions, including household chores, socialising, and work. Participants answer each question on a 7-point Likert scale (0= not at all confident, 6=completely confident). The total score ranges from 0 to 60, where higher scores reflect stronger self-efficacy (Nicholas 2007).

Patient health questionnaire (PHQ-9)
This 9-item questionnaire is a valid and reliable measure of the severity of depression (Kroenke et al., 2001). The participant rates nine statements on depression (0 = not at all, 3 = nearly every day). The total score is the sum of scores on all nine items, and ranges from 9 to 27 points. Higher scores reflect higher levels of depression.

Quality of life
The EuroQoL (EQ-5D) measures health-related quality of life. Participants rate their health status on five dimensions of mobility, personal care, usual activities, pain, anxiety/depression, as no problems, moderate problems or severe problems. Each health state is ranked and transformed into a single utility score (Connelly 2009). The total score ranges from 0 to 1, where higher scores reflect greater quality of life (Gusi et al., 2010). In addition, the anxiety and depression dimension of the EQ-5D was considered as a psychological factor: participants rating I am not anxious or depression, I am moderately anxious or depressed, or I am extremely anxious or depressed (Connelly 2009).

Physical activity
Participation in leisure time physical activity was measured by the Active Australia Survey (AAS) (Australian Institute of Health and Welfare 2004). This is a reliable and valid tool consisting of nine questions to measure physical activity (Timperio et al., 2002). The core eight questions assess a person's frequency and duration of participation in walking, vigorous gardening or heavy yard work, moderate and vigorous activity during the previous week. The total physical activity score is calculated as the sum of minutes spent walking and participating in moderate and vigorous activity during the past week.

Anthropometrics and hip abductor muscle strength
Waist girth (cm) and hip circumference (cm) were measured at the level of the umbilicus and greater trochanters respectively, with a measuring tape, and the waist-to-hip ratio was calculated (waist girth (cm) / hip circumference (cm)).

Hip abductor muscle torque was measured in supine with a handheld dynamometer (Nicholas, Lafayett, IN47903 USA) (Mellor et al., 2016), which was anchored to a rigid point with a non-elastic strap. The torque (Nm) was calculated as the product of the force and lever length (distance from the greater trochanter to the midpoint of the dynamometer placement) and then standardized by body weight (Nm/kg) = ((force F (N) x lever arm D (m)) / mass (kg)). Previous literature has shown good to excellent inter-rater reliability (ICC > 0.7) in hip abductor muscle strength measured with a belt fixated hand held dynamometer (Ieiri et al., 2015; Takeda et al., 2017). Pain inhibition experienced during hip abductor muscle strength testing was measured. Participants reported whether they considered that their pain limited their capacity to generate maximum effort during the testing by 'yes' or 'no'.

Procedure

There was one examiner at each site performing physical screening, anthropometric, and strength testing (Brisbane and Melbourne). Both examiners were registered physiotherapists with post graduate musculoskeletal physiotherapy qualifications. Volunteers that passed the phone screening then underwent physical screening. After physical screening, surveys were completed, including the VISA-G, AAS, PCS, PSEQ, PHQ-9, and the EQ-5D. Participants who met the clinical criteria then underwent magnetic resonance imaging (MRI) to confirm the diagnosis of gluteal tendinopathy. Imaging was done within two weeks after the physical screening and reported by a qualified radiographer (Mellor et al., 2016).

Statistical analysis

Statistical analysis was performed by an independent researcher. K-means algorithm cluster analysis was performed to classify participants into three subgroups: mild, moderate and severe pain and disability, as per methods in previous similar studies (Coombes 2012; Sterling et al., 2004). Cluster analysis in this study was based on total VISA-G scores.

A multivariate analysis of covariance (MANCOVA) was performed to evaluate whether individual characteristics differed between these subgroups, including sex and site of measurement as covariates. This was followed up with Bonferroni post-hoc tests to determine mean differences (MD) and 95% confidence intervals (CI). Significance for the MANCOVA was set a-priori at $p<0.05$. Chi square test was used to test for differences across subgroups for categorical data (e.g., education level, occupation, anxiety and depression dimension of the EQ-5D and pain inhibition during strength testing).

To enable graphical summary of the size of between subgroup differences relative to the variability for each measure, standardized mean differences (SMD) and the 95%CI were calculated (Higgins and Green 2008). SMD of 0.2 was considered small, 0.6 moderate, 1.2 large, and ≥2.0 very large (Hopkins 2013). SMDs were calculated in Review Manager (RevMan) 5.0, all other calculations were performed with SPSS version 24.0 (IBM, New York, USA).

Results

Two hundred and four participants were recruited, with a mean age of 55 years (standard deviation (SD) 9, range 36-71 years), and 82% of participants were female. Ninety nine participants were recruited in Brisbane, 104 participants in Melbourne. No significant interaction was found between the site of measurement and socio-economic status, measured by level of education (χ^2 (4) = 3.16, p=0.53) and occupation (χ^2 (4) = 7.33, p=0.12).The average body mass index (BMI) was 27.45 kg/m^2 (SD 5.12), with 28% (n=57) having a BMI >30. (Table 1). Median duration of pain was 24 months (Interquartile range (IQR) 8-48, minimum 3, maximum 192 months). The majority (n=156, 77%) had unilateral pain. VISA-G was missing for one participant, enabling analysis of 203 out of 204 participants. K-means cluster analysis of the VISA-G scores identified three subgroups, referred to herein as mild (n=51; mean 76.5; range 68-98), moderate (n=103; mean 59.0; range 51-67) and severe (n=49; mean 42.7; range 14-50) pain and disability (Table 1). Average pain and worst pain were significantly higher for the severe group compared to the mild and moderate groups (Table 1).

Psychological factors

Significant group differences were found for all psychological factors (all p<0.001, Table 1, Fig. 1). The severe group had significantly higher pain catastrophizing than both mild (MD 10.22; 95%CI 6.16, 14.27; p<0.001) and moderate (MD 5.31; 95%CI 1.82, 8.80; p=0.001) groups. The severe group also had lower pain self-efficacy compared to the mild (MD -13.20; 95%CI -17.16, -9.24; p<0.001) and moderate (MD -6.94; 95%CI -10.34, -3.53; p<0.001) groups as well as higher depression scores compared to both moderate (MD 2.82; 95%CI 1.09, 4.55; p<0.001) and mild groups (MD 4.85; 95%CI 2.84, 6.86; p<0.001).

Quality of life

Significant group differences for quality of life were found (p<0.001). Quality of life was significantly lower in the severe group compared to the mild (MD -0.13; 95%CI -0.19, -0.07; p<0.001) and moderate (MD -0.08; 95%CI -0.13, -0.03; p=0.001) group (Table 1, Fig. 1).
A significant interaction was found between the anxiety and depression subscale of the EQ-5D and subgroups of pain and disability (χ^2 (4) = 11.04, p<0.05; Table S1).

Physical activity

Significant group differences were found for total physical activity time and time spent in vigorous physical activity. Significantly lower total physical activity levels were found only in the severe group compared to the mild group (MD -258.23 minutes; 95%CI -462.84, -53.63; p=0.01) (Table 1). Lower vigorous activity levels were found in the severe group compared to the mild group (MD -114.25 minutes; 95%CI -192.83, -35.67; p=0.002) and in the moderate group compared to the mild group (MD -76.81 minutes; 95%CI -144.43, -9.18; p=0.02) (Table 1, Fig. 1).

Anthropometrics

Waist girth and waist to hip ratio were different across subgroups (p<0.05), sex (p<0.001) and study site (p<0.01). Post hoc analysis revealed that only the severe group compared to the mild group had significantly greater waist girth (MD 7.39 cm; 95%CI 1.27, 13.51; p=0.01) and greater waist to hip ratio (MD 0.04; 95%CI 0.00, 0.08; p=0.05) (Table 1, Fig. 1). Men had a greater waist girth (MD 8.70 cm; 95%CI 3.70, 13.70; p=0.01) and waist to hip ratio (MD 0.11; 95%CI 0.08, 0.14; p<0.001) than women. Participants from Brisbane had a greater waist girth (MD 6.38 cm; 95%CI 1.38, 11.38; p=0.01) and waist to hip ratio (MD 0.05; 95%CI 0.02, 0.09; p<0.01) than participants from Melbourne. Hip circumference did not show subgroup, sex, or study site differences.
BMI was significantly different across subgroups (p=0.02) and study site (p=0.04). Post hoc analysis revealed greater BMI in only the severe group compared to the moderate group (MD 2.30 kg/m^2; 95%CI 0.19, 4.41; p=0.03). In males only, no significant group differences in BMI were found, however, females showed significantly greater BMI in the severe group compared to both the moderate group (MD 2.68 kg/m^2; 95%CI 0.31, 5.05; p=0.02) and the mild group (MD 3.44 kg/m^2; 95%CI 0.58, 6.31; p=0.01) (Table 1).

Hip abductor muscle strength
There were no significant subgroup differences for hip abductor muscle torque ($p=0.52$), but significant sex differences ($p<0.001$) and study site differences ($p<0.01$) were found. Post-hoc analysis revealed that these differences were mainly driven by the higher hip abductor torque scores of males from Brisbane (Figure S1).
No significant interaction was found between reported pain inhibition during strength testing and subgroups of pain and disability ($\chi 2$ (2) = 2.21, $p=0.33$).

Discussion

This is the first study to assess a range of physical and psychological factors (pain catastrophizing, pain self-efficacy, and depression) between subgroups of individuals with gluteal tendinopathy reporting different levels of pain and disability. Our data indicate that individuals with greater severity of pain and disability present with greater pain catastrophizing and depression levels, less pain self-efficacy, poorer quality of life, greater BMI and greater waist girth. In addition to these findings, those with more severe pain and disability, had lower total and vigorous physical activity levels compared to mild pain and disability. These results justify the need for additional research on the role of these factors in the multi-disciplinary management of patients presenting with severe pain and disability in gluteal tendinopathy.

Depression levels, measured by both the PHQ-9 and the anxiety and depression subscale of the EQ-5D were greater in the severe pain and disability subgroup. Based on the latter questionnaire, 37% of the severe group had *some* or *extreme* problems with anxiety and depression compared with 18% and 14% in the moderate and mild subgroups respectively (Table S1). Similarly, pain catastrophizing was found to be incrementally greater across the subgroups while pain self-efficacy was lower. Greater involvement of psychological factors in more severe cases is consistent with previous literature in other persistent musculoskeletal injuries (Das De et al., 2013; de Moraes Vieira et al., 2014). In addition, there is evidence of associations between depression and lateral elbow tendinopathy (Alizadehkhaiyat et al., 2007; Garnevall et al., 2013) as well as between pain catastrophizing and upper limb rotator cuff tendinopathy (Kromer et al., 2014). In Achilles tendinopathy, evidence suggests kinesiophobia has a negative impact on the effectiveness of treatment (Silbernagel et al., 2011) and is associated with greater psychological burden during daily and highly valued activities (Mc Auliffe et al., 2017). In gluteal tendinopathy specifically, quality of life was shown to be similar to end stage hip OA and lower than healthy controls (Fearon et al., 2014), as measured with the Assessment of Quality of Life (AQoL) (Hawthorne and Osborne 2004). As the AQoL consists of five scales including psychological well-being, this measure could possibly reflect an association between mental health and gluteal tendinopathy. Breakdown of the total AQoL into scores of the separate dimensions were however not provided (Fearon et al., 2014). Pain catastrophizing and depression are associated with poor prognosis in other musculoskeletal conditions like low back pain (Hill et al., 2008; Pinheiro et al., 2016; Wertli et al., 2014). In low back pain, this has led to the integration of psychological factors into a prognostic tool to stratify care (Hill et al., 2008; Hill et al., 2011). Individuals in the highest risk group were referred for psychologically-informed physiotherapy to address physical symptoms and function, as well as psychosocial obstacles (Hill et al., 2008; Hill et al., 2011). A randomized controlled trial testing this stratified care model, showed that the stratified care treatment had better clinical outcomes and an increase in generic health benefits compared to the current best care in low back pain (Hill et al., 2008; Hill et al., 2011). These findings of successfully stratifying care in low back pain and our findings of differences in psychological features between subgroups of pain and disability implicates a need for clinicians to consider psychological factors when managing individuals with more severe gluteal tendinopathy.

Our population was, on average, overweight and had a similar BMI to the average middle aged healthy Australian female population (BMI 26.9 kg/m^2; SD 5.4; mean age= 56.4 years; SD 1.4) (Tudor-Locke et al., 2009). Although BMI was found to be greater in the severe group compared to the moderate group, this was not significant in males, which may be due to low statistical power given the smaller sample of men (n=36). Differences in sex distribution between studies might elucidate contradictory results found on BMI between individuals with gluteal tendinopathy and healthy controls in previous studies (Allison et al., 2015; Fearon et al., 2017; Flack et al., 2012; Ganderton et al., 2017). BMI is a measure of adiposity, as are waist circumference, hip circumference and waist-hip ratio (Park et al., 2005). In our study, severe cases showed greater BMI, waist to hip ratio and waist circumference compared to less severe cases. Significantly larger greater trochanteric girth, but not waist girth, hip circumference and waist-to-hip-ratio was observed in individuals with gluteal tendinopathy compared to healthy controls (Fearon et al., 2012). Greater adiposity is thought to play a role in the pathogenesis of tendinopathy, either by increasing mechanical loads through the tendon (Gaida et al., 2009; Magnusson et al., 2010; Malliaras et al., 2007; Scott et al., 2015), or systemically via high cytokine levels and chronic low-grade microvascular inflammation, which adversely affect tendon matrix structure (Biancalana et al., 2010; Gaida et al., 2009; Park et al., 2005).

The Australian Institute of Health and Welfare recommends adults undertake 30 minutes of moderate activity on 5 days of the week (Australian Institute of Health and Welfare 2004). Using the AAS to measure self-reported physical activity in the previous week, a quarter of our sample (25%) was classified as not sufficiently active (<150 minutes/week of physical activity) (Australian Institute of Health and Welfare 2004). Commensurate with our gluteal tendinopathy population, a previous study on individuals with hip osteoarthritis also reported 22% of their cohort was insufficiently active based on a similar metric (0-30 minutes per day) (Holsgard-Larsen and Roos 2012). Interestingly, total physical activity was significantly greater in the mild group compared to the severe group, and vigorous activity was significantly greater in the mild group compared to both moderate and severe subgroups. Vigorous physical activity was defined as 'activities which made you breathe harder or puff and pant (e.g. jogging, cycling, aerobics, competitive tennis)' (Australian Institute of Health and Welfare 2004). One explanation of our results could be that pain evoked during vigorous physical activity in the more severe groups might have led to reduced physical activity. Fear of pain or injury (kinesiophobia) may also potentially lead to reduced physical activity. Although kinesiophobia was not measured in this or other studies of gluteal tendinopathy, its investigation in future studies is warranted. From a physical perspective, inactivity or sedentary behaviours might lead to reduced tissue mechanical properties and predispose to greater severity of pain and disability. Furthermore, regular involvement in vigorous physical activity may protect from development of severe pain, due to more efficient endogenous analgesia in such individuals (Grimaldi and Fearon 2015;

Naugle et al., 2012). Future evaluation to determine whether increases in physical activity occur with resolution of symptoms, will provide useful information.

Bilateral hip abductor muscle weakness has been previously reported in individuals with gluteal tendinopathy compared to healthy controls (Fearon et al., 2017; Ganderton et al., 2017), including a subgroup of the present cohort (Allison et al., 2015). Average hip abductor torque ranged from 0.77 Nm/kg to 0.88 Nm/kg between subgroups, values that are comparable with another recent study (0.75Nm/kg, SD 0.08) (Ganderton et al., 2017). These results suggest that hip abductor muscle weakness may be associated with the presence of gluteal tendinopathy compared to asymptomatic individuals, but not the severity of pain and disability. This hypothesis is in line with the finding that no significant interaction was found between reported inhibition due to pain during hip abductor strength testing and subgroups of pain and disability. Additionally, hip abductor muscle weakness has been shown regardless of pain limiting the maximum effort during strength testing in a subgroup of this cohort compared to healthy controls (Allison et al., 2015). Thus individuals with gluteal tendinopathy present with pain and discomfort during strength testing compared to healthy controls (Allison et al., 2015; Ganderton et al., 2017), but reported pain does not seem to influence hip abductor muscle strength.

The main limitation of this study is that we cannot infer causality given the cross-sectional design. Thus, future studies are needed to determine the prognostic significance of the factors identified in this study. Our study could have benefitted from a control group, as scientific reference data of healthy participants are limited for most measures. While the AAS is commonly used as a measure of self-reported activity (Brown et al., 2016; Pavey et al., 2013; Peeters et al., 2015), quantifiable activity measurement devices (e.g. accelerometers) may help elucidate the complex relationship between physical activity and pain and disability in individuals with gluteal tendinopathy. A strength of our study is that a large cohort of individuals with gluteal tendinopathy were recruited (n=203) from two different metropolitan regions in Australia, which increases representation of the general population.

Conclusions

In summary, more severe pain and disability is characterized by greater psychological distress, poorer quality of life, waist girth and BMI, but not by hip abductor strength.

Author Contributions

All authors made substantial contributions to conception of the study, interpretation of data and critical revision of the content. R. Mellor and P. Nicolson performed data acquisition. M. Plinsinga performed data analysis, and drafted the article. All authors approved the version submitted.

Table 1. Demographics and characteristics of the total gluteal tendinopathy sample and the subgroups of pain and disability based on the VISA –G. Data are presented as means (SD). Significant differences between subgroups calculated with a MANOVA adjusted for sex and site of measurements are presented as mean differences, 95% confidence intervals, and p-values.

	Gluteal tendinopathy							
	Total (n=203)	Mild (n=51)	Moderate (n=103)	Severe (n=49)		Severe vs moderate	Severe vs mild	Moderate vs mild
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	p-value	MD (95%CI; p-value)	MD (95%CI; p-value)	MD (95%CI; p-value)
VISA-G /100	59.5 (13.2)	76.5 (7.3)	59.0 (4.8)	42.7 (6.1)	<0.001	-16.3 (-18.8, -13.9; <0.001*)	-34.0 (-36.8, -31.2; <0.001*)	-17.7 (-20.1, -15.2; <0.001*)
Average pain last week /10	5.0 (1.5)	4.5 (1.4)	4.9 (1.4)	5.7 (1.6)	<0.001	0.8 (0.2, 1.4; 0.005*)	1.2 (0.5, 1.9; <0.001*)	0.357 (-0.3, 1.0; 0.49)
Worst pain last week /10	7.1 (1.6)	6.7 (1.4)	7.0 (1.6)	7.8 (1.3)	0.001	0.8 (0.2, 1.4; 0.009*)	1.1 (0.4, 1.8; 0.001*)	0.3 (-0.3, 1.0; 0.71)
Age years	54.8 (8.9)	55.5 (8.6)	54.7 (9.3)	54.5 (8.3)	0.60	-0.3 (-4.0, 3.4; 1.00)	-0.6 (-4.9, 3.8; 1.00)	-0.2 (-3.9, 3.5; 1.00)
Body Mass Index kg/m^2	27.5 (5.1)	27.0 (4.6)	26.9 (5.4)	29.1 (4.7)	0.02	2.3 (0.2, 4.4; 0.03*)	2.3 (-0.2, 4.7; 0.08)	-0.0 (-2.2, 2.1; 1.00)
Males only	27.8 (3.8)[a]	29.2 (3.5)[a]	26.8 (3.5)[a]	27.0 (4.6)[a]	0.22	-0.0 (-4.4, 4.3; 1.00)	-2.3 (-6.5, 2.0; 0.58)	-2.3 (-5.7, 1.2; 0.34)
Females only	27.4 (5.4)[b]	26.0 (4.8)[b]	26.9 (5.7)[b]	29.5 (4.6)[b]	0.01	2.7 (0.3, 5.1; 0.02*)	3.4 (0.6, 6.3; 0.01*)	0.8 (-1.7, 3.3; 1.00)
Waist girth cm	88.5 (13.4)	86.5 (11.8)	87.7 (14.1)	92.5 (12.8)	0.01	5.2 (-0.0, 10.5; 0.05)	7.4 (1.3, 13.5; 0.01*)	2.2 (-3.1, 7.4; 0.97)
Hip circumference cm	104.6 (10.1)	103.0 (8.8)	104.1 (10.8)	107.3 (9.6)	0.09	3.4 (-0.8, 7.6; 0.15)	4.0 (-0.9, 8.8; 0.15)	0.5 (-3.6, 4.7; 1.00)
Waist to hip ratio	0.9 (0.1)	0.8 (0.1)	0.8 (0.1)	0.9 (0.1)	0.05	0.0 (-0.0, 0.1; 0.22)	0.0 (0.0, 0.1; 0.05*)	0.0 (-0.0, 0.1; 0.91)
Torque affected side Nm/kg	0.8 (0.3)	0.9 (0.4)	0.8 (0.3)	0.8 (0.4)	0.52	-0.1 (-0.2, 0.1; 1.00)	-0.1 (-0.2, 0.1; 0.84)	-0.0 (-0.2, 0.1; 1.00)
Total physical activity min/week	464.8 (428.4)	619.9 (429.8)	442.8 (407.2)	349.5 (432.9)	0.01	-97.2 (-273.3, 78.9; 0.55)	-258.2 (-462.8, -53.6; 0.01*)	-161.0 (-337.1, 15.1; 0.09)
Vigorous activity min/week	102.8 (165.6)	172.6 (201.0)	91.3 (155.0)	54.2 (119.6)	<0.01	-37.4 (-105.1, 30.2; 0.55)	-114.3 (-192.8, -35.7; 0.002*)	-76.8 (-144.4, -9.2; 0.02*)
Pain catastrophizing scale /52	13.6 (9.0)	8.6 (5.7)	13.6 (8.5)	18.8 (10.0)	<0.001	5.3 (1.8, 8.8; 0.001*)	10.2 (6.2, 14.3; <0.001*)	4.9 (1.4, 8.4; 0.002*)
Pain self-efficacy scale /60	47.7 (9.3)	53.9 (5.6)	47.8 (8.1)	40.8 (10.0)	<0.001	-6.9 (-10.3, -3.5; <0.001*)	-13.2 (-17.2, -9.2; <0.001*)	-6.3 (-9.7, -2.9; <0.001*)
Depression questionnaire /27	4.7 (4.4)	2.5 (2.3)	4.5 (4.0)	7.4 (5.6)	<0.001	2.8 (1.1, 4.6; <0.001*)	4.9 (2.8, 6.9; <0.001*)	2.0 (-0.3, 3.8; 0.02*)
Quality of life /1	0.7 (0.1)	0.8 (0.1)	0.7 (0.1)	0.7 (0.2)	<0.001	-0.1 (-0.1, -0.0; 0.001*)	-0.1 (-0.2, -0.1; <0.001*)	-0.1 (-0.1, 0.0; 0.10)

SD: standard deviation; MD: mean difference

[a] Total males n=36, mild n=15, moderate n=14, severe n=7.

[b] Total females n=167, mild n=36, moderate n=89, severe n=42

* Significance is set at p<0.05

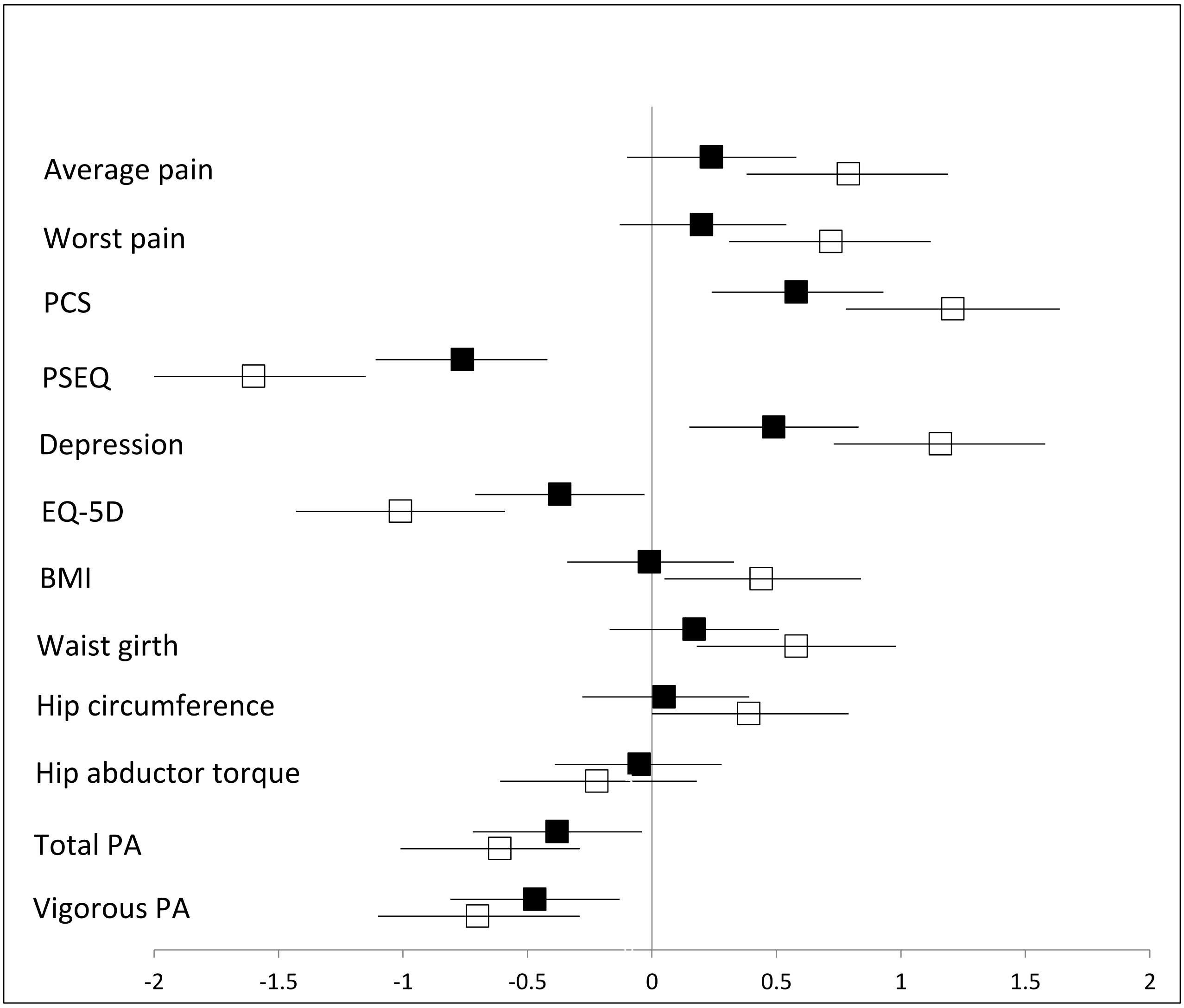

Figure 1. Standardized mean differences (95% CI) of the measures between the mild and moderate subgroups (filled marker) and the mild and severe subgroups (open marker), the mild group set as reference group. Scores > 0 indicate greater pain, pain catastrophizing (PCS), greater pain self-efficacy (PSEQ), greater depression (depression), greater quality of life (EQ-5D), greater body mass index (BMI), greater waist girth, greater hip circumference, greater hip abductor torque, and higher physical activity (PA) levels.

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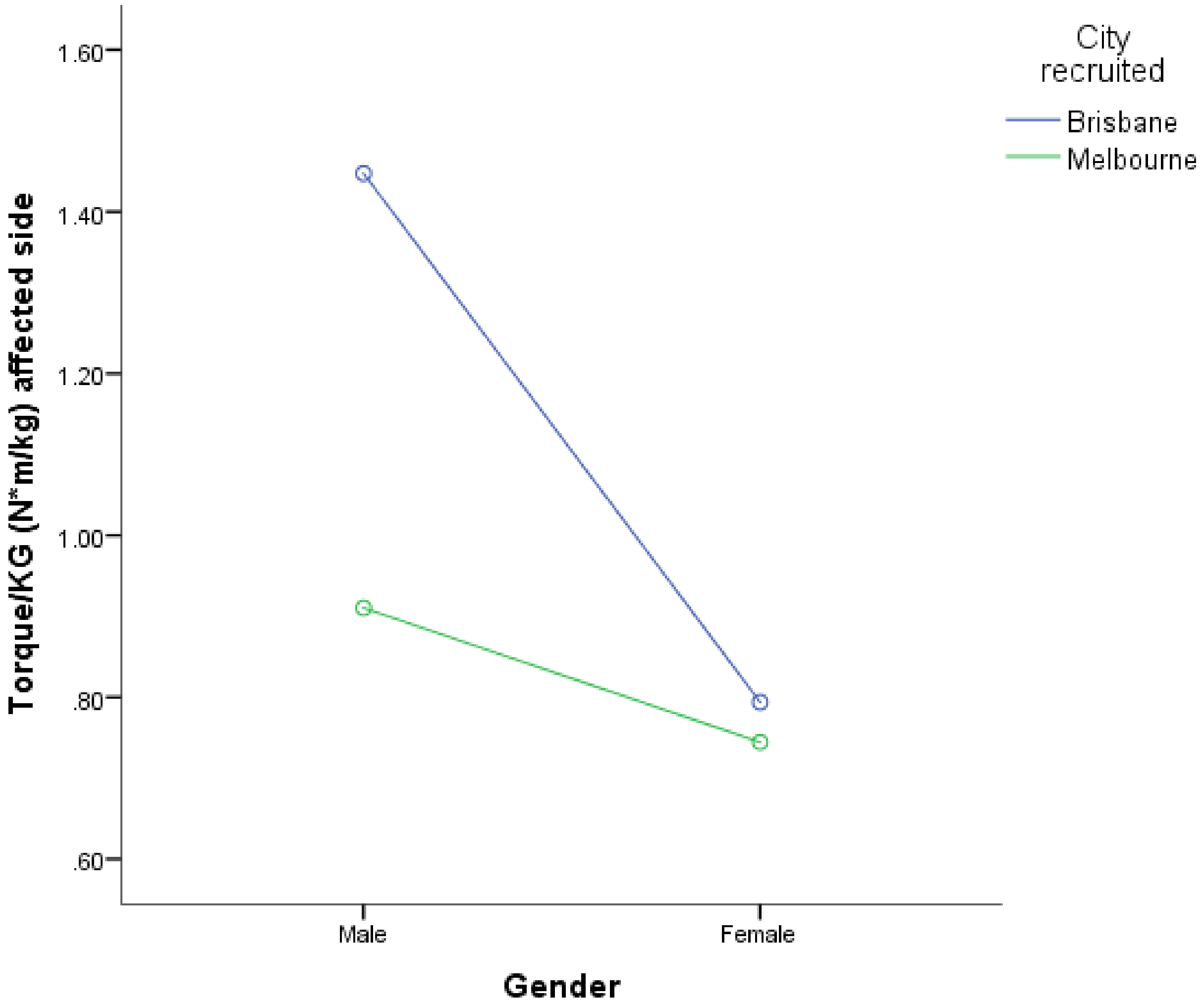

Figure S1. Interaction plot highlighting interaction between males and females across sites for torque (N*m/kg)

Table S1. Subscale anxiety and depression of the EQ-5D in the subgroups of pain and disability in 203 individuals with gluteal tendinopathy (χ^2 (4) = 11.04, $p<0.05$).

	Mild (n=51)	Moderate (n=103)	Severe (n=49)
No problems	44 (86%)	84 (82%)	31 (63%)
Some problems	7 (14%)	19 (18%)	17 (35%)
Extreme problems	0 (0%)	0 (0%)	1 (2%)