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Systematic Review

Physical findings differ between individuals with greater trochanteric pain syndrome and healthy controls: A systematic review with meta-analysis

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ABSTRACT

Background: Understanding of the biopsychosocial characteristics of greater trochanteric pain syndrome (GTPS), a prevalent lower limb tendinopathy, is currently lacking.
Objectives: To quantify differences in participant characteristics between individuals with GTPS and healthy control participants.
Design: Systematic review of original studies with meta-analyses where appropriate.
Methods: A comprehensive electronic search was undertaken in Pubmed, EMBASE, Web of Science and CINAHL for terms referring to GTPS. Studies that provided comparison of individuals with clinically characterized GTPS with healthy controls were included. Study quality was rated with the Joanna Briggs Institute Critical Appraisal Checklist for Cross Sectional Studies. Standardized mean differences were calculated and supported by narrative synthesis or meta-analyses where appropriate. Certainty of evidence was assessed based on the GRADE guidelines.
Results: The search revealed 2798 studies, of which 13 studies from five research groups were included. There were 229 participants with at least three months duration of GTPS and 193 control participants. Individuals with GTPS displayed larger greater trochanteric width, greater body mass index, lower hip abductor muscle strength, higher hip abductor muscle activity, altered single leg loading and gait parameters including shorter step length and velocity. No studies investigating psychological features or sensory perception were identified. Quality of life was investigated in a single study.
Conclusions: Compared to healthy controls, participants with GTPS are more overweight, have poorer hip abductor muscle function and altered gait parameters. Overall quality of evidence across studies was very low based on GRADE guidelines.

1. Introduction

Greater trochanteric pain syndrome (GTPS) clinically presents as pain and tenderness at, or around, the greater trochanter, aggravated by direct pressure on palpation, lying on the affected side, and functional activities requiring single leg stance such as walking and stair climbing (Bancroft and Blankenbaker, 2010; Bird et al., 2001; Connell et al., 2003). This collection of clinical symptoms is commonly attributed to certain pathologies including tendinopathy of the gluteus medius and minimus muscles and trochanteric bursitis (Bird et al., 2001; Kingzett-Taylor et al., 1999; Kong et al., 2007), but also plausibly gluteal tendon tears (Bird et al., 2001). A study looking at the prevalence and incidence of patients presenting with tendinopathies in a Dutch general practice found GTPS to have the highest prevalence (4.22 per 1000 person years) and incidence (3.29 per 1000 person years) of all lower limb tendinopathies (Albers et al., 2016).

Despite the high prevalence of GTPS, a thorough understanding of the characteristics of people who have this condition is in its infancy. Recent systematic reviews in other tendinopathies described associations between tendinopathy and adiposity (e.g. body mass index (BMI), waist-to-hip ratio) (Franceschi et al., 2014; Scott et al., 2015; van der Worp et al., 2011), fear of movement, catastrophizing (Mallows et al., 2016), hormonal imbalance (Oliva et al., 2016), and sensory-motor impairments (Heales et al., 2014). Currently it is not clear whether GTPS shares similar biopsychosocial characteristics to other tendinopathies. Therefore, the following research question was specified: Are there differences in characteristics between individuals with GTPS and healthy control participants? It is proposed that this information will

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provide a basis for future research, including the identification of impairments that could be the focus of targeted treatment strategies.

2. Methods

2.1. Search strategy

This systematic review was performed according to the PRISMA guidelines for reporting systematic reviews (Harris et al., 2014) (Supplementary Table 1), and registered at the international prospective register of systematic reviews (PROSPERO) (CRD42016052822). An electronic search was performed by two independent researchers in Pubmed, EMBASE, Web of Science and CINAHL to identify studies that met the inclusion criteria. The electronic search was undertaken to identify all English language studies using the following phrases as MeSH and/or text words until 5th of March 2019: 'gluteal tendinopathy', 'greater trochanteric pain syndrome', 'gluteal bursitis', 'trochanteric bursitis', 'lateral hip pain', 'gluteal tendon tears'. The specific search terms in Pubmed were as follows: ((((("gluteal tendinopathy") OR "greater trochanteric pain syndrome") OR "gluteal bursitis") OR "trochanteric bursitis") OR "lateral hip pain") OR "gluteal tendon tears".

2.2. Study selection

After the electronic search, duplicates were removed, and titles and abstracts were screened by two independent researchers. Reference lists of all selected articles were independently screened to detect studies not identified by the electronic search. Potentially relevant full-text articles were retrieved and assessed for eligibility. Disagreements were resolved through consultation with the senior author. To be included, studies had to contain research on any measure of a patient characteristic in a cohort with clinically diagnosed GTPS, defined as lateral hip pain, gluteal tendinopathy, gluteal bursitis, gluteal tears or a combination of the previous; and included a healthy control group in addition to the GTPS group. No restrictions to publication date were made. Review articles, studies published in a language other than English and studies for which full text was not available were excluded. Randomised or controlled trials were eligible for inclusion, but only data from baseline were considered herein.

2.3. Methodological quality assessment

The Joanna Briggs Institute Critical Appraisal Checklist for Cross Sectional Studies (JBI) was used to assess the study quality (Moola et al., 2017). Items were scored as 1 if the item was satisfied or 0 if the item was not satisfied or unclear. The total score for methodological quality was derived as the sum of all items. No studies were excluded based on quality. Quality assessment was performed by two reviewers, with a third reviewer available for consensus if disagreement was noted.

2.4. Data extraction

Data extraction was performed by a single authorand 54% (7/13) of the papers were independently extracted by a second author to ensure quality of the data extraction. Data on sample size, diagnostic criteria, population characteristics (age, sex, BMI), and all outcome measures for GTPS and healthy controls participants were extracted and summarized. Means, standard deviations (SD), and sample sizes were extracted for all continuous outcomes. Corresponding authors of eight papers were asked to provide additional information of their data (Allison et al., 2016a; Fearon et al., 2013, 2014a, 2015, 2017; Flack et al., 2012; Ganderton et al., 2017a; Viradia et al., 2011), with additional data of six papers received (Allison et al., 2016a; Fearon et al., 2012, 2013, 2014a, 2017; Ganderton et al., 2017a).

2.5. Data analysis

Inter-rater reliability for JBI items was examined using kappa (κ) statistics (SPSS version 21.0). Reliability was considered as slight (0.00–0.2), fair (0.21–0.4), moderate (0.41–0.6), substantial (0.61–0.8) or almost perfect (0.81–1.0) (Landis and Koch, 1977).

Categorical variables were presented as frequency count (percentage), continuous variables were reported as means (standard deviation) or median (interquartile range (IQR)) as required. Standard mean differences (SMDs) were computed for each outcome to estimate mean differences between groups (GTPS versus healthy controls) relative to the pooled standard deviation (Higgins and Green, 2008). For continuous outcomes, SMDs and 95% confidence intervals (CI) were calculated using a random effect method. A 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 Version 5.2 software. Meta-analysis was performed when similar outcome measures were reported by ≥ 2 studies. Statistical heterogeneity of I^2 = 25%, 50%, and 75% was considered respectively low, moderate, and high (Higgins et al., 2003). In case of overlap between participants across papers, the paper with the greatest sample size was considered for comparison.

The GRADE approach was employed to assess the overall quality of evidence for outcomes measured across ≥2 studies (Schünemann et al., 2013). Evidence was downgraded by one level for limitations of design (total JBI score ≤ 50%), serious inconsistency (heterogeneity > 75%), indirectness, imprecision of effect estimates, and publication bias. There was no possibility to upgrade evidence of cross-sectional study designs by using the original GRADE working group criteria (Schünemann et al., 2013).

3. Results

3.1. Study selection

The electronic search strategy retrieved a total of 3234 articles (Fig. 1). After removal of duplicates and title and abstract screening, 20 articles were identified for full-text screening. After evaluating full-text articles for eligibility, seven studies were excluded (Fig. 1). Three studies were excluded because data presented was not compared to a control group (Connell et al., 2003; Furia et al., 2009; Klontzas and Karantanas, 2014), one study because the control group consisted of individuals diagnosed with hip osteoarthritis (Fearon et al., 2014b), and three other studies were excluded because the population was not clinically diagnosed with GTPS (Board et al., 2014; Ganderton et al., 2017b; Koseoglu et al., 2014).

A total of 13 papers were included (Allison et al., 2015, 2016a, 2016b, 2016c, 2017; Fearon et al., 2012, 2013, 2014a, 2015, 2017; Flack et al., 2012; Ganderton et al., 2017a; Viradia et al., 2011), authored by five different research groups.

3.2. Quality assessment

Overall, the median methodological quality score was 5 (range 3–7) out of possible 8 (Table 1). Inter-rater agreement for methodological quality of the studies was almost perfect (κ = 0.929, $p < 0.01$) with 100/104 agreements (Landis and Koch, 1977). Consensus was reached without requiring a third party. The majority of studies (eight studies, 62%) reported the use of both clinical and imaging assessment as eligibility criteria (Allison et al., 2015, 2016a, 2016b, 2016c, 2017; Fearon et al., 2013, 2014a, 2017). Most studies reported insufficient details about the study sample (age, sex, weight/BMI) and injury characteristics (duration and severity of GTPS) (Table 1). Only three studies clearly reported reliability (27%) (Allison et al., 2015; Fearon et al., 2012, 2015). Validity was reported in just one study (8%) (Fearon et al., 2015).

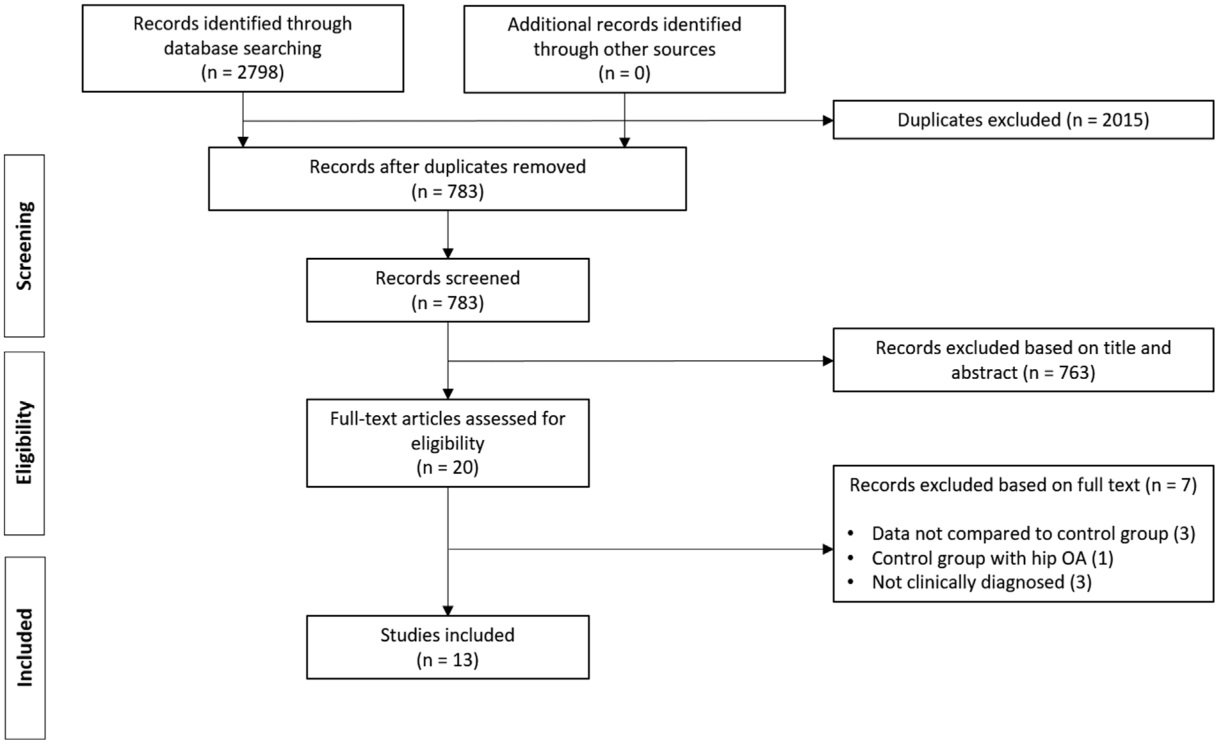

Fig. 1. Flow chart of the study selection process.

Table 1
Results of the methodological quality assessment according to The Joanna Briggs Institute Critical Appraisal Checklist for Cross Sectional Studies (JBI).

■ = Yes □ = No ▒ = Unclear

Study	1. Were the criteria for inclusion in the sample clearly defined?	2. Were the study subjects and the setting described in detail?	3. Was the exposure measured in a valid and reliable way?	4. Were the objective, standard criteria used for measurement of the condition?	5. Were confounding factors identified?	6. Were strategies to deal with confounding factors stated?	7. Were the outcomes measured in a valid and reliable way?	8. Was appropriate statistical analysis used?	TOTAL
Allison et al(Allison et al., 2015)	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	7
Allison et al(Allison et al., 2016c)	Yes	No	Yes	Yes	Yes	Yes	Unclear	Yes	6
Allison et al(Allison et al., 2016b)	Yes	Unclear	Yes	Yes	No	Yes	Unclear	Yes	5
Allison et al(Allison et al., 2016a)	Yes	No	Yes	Yes	No	Yes	Unclear	Yes	5
Allison et al(Allison et al., 2017)	Yes	No	Yes	Yes	No	No	Unclear	Yes	4
Fearon et al(Fearon et al., 2017)	Yes	No	Yes	Yes	No	Yes	Unclear	Yes	5
Fearon et al(Fearon et al., 2014a)	Yes	Yes	Yes	Yes	Yes	Yes	Unclear	Yes	7
Fearon et al(Fearon et al., 2012)	Yes	No	Yes	Yes	Yes	Yes	Unclear	Yes	6
Fearon et al(Fearon et al., 2015)	Yes	No	Yes	Yes	No	No	Yes	Yes	5
Fearon et al(Fearon et al., 2013)	Yes	No	Yes	Yes	No	Yes	Unclear	Yes	5
Flack et al(Flack et al., 2012)	Yes	No	Yes	Unclear	No	Yes	Unclear	Yes	4
Ganderton et al(Ganderton et al., 2017a)	Yes	No	Yes	Yes	No	Yes	Unclear	Yes	5
Viradia et al(Viradia et al., 2011)	No	No	Yes	Unclear	No	Yes	Unclear	Yes	3
Total studies 'yes'	12	2	13	11	4	11	1	13	

3.3. Participant characteristics

Participant characteristics and injury characteristics are presented in Supplementary Table 2. A total of 229 participants with GTPS and 193 healthy controls were included in the review (Allison et al., 2015; Fearon et al., 2012; Flack et al., 2012; Ganderton et al., 2017a; Viradia et al., 2011). Participants in the included studies were predominantly female (70%–100%). The mean age of participants ranged from 44 to 62 years.

Some variability in clinical and diagnostic criteria were evident between studies. The five studies by Allison et al. investigated individuals diagnosed with gluteal tendinopathy (clinical diagnosis plus imaging), one study included individuals diagnosed with trochanteric bursitis (clinical diagnosis only) (Viradia et al., 2011), and another study included individuals with lateral hip reproduced by palpation over the greater trochanter and resisted hip abduction (Flack et al., 2012). The remaining studies used the umbrella term GTPS, four using clinical diagnosis only (Fearon et al., 2013, 2014a, 2015; Ganderton et al., 2017a) and two using clinical diagnosis plus imaging (Fearon et al., 2012, 2017).

3.4. Differences between GTPS and controls

Supplementary Table 3 summarises the outcome measures for comparison between individuals with GTPS and healthy controls.

3.5. Anthropometric features

BMI was significantly greater in GTPS compared to controls in one, but not in three other studies reporting this outcome (Allison et al., 2015; Fearon et al., 2017; Flack et al., 2012; Ganderton et al., 2017a). Meta-analysis of all four studies indicated a moderate difference for BMI (SMD 0.64; 95%CI 0.35 to 0.93; $p < 0.001$), with low heterogeneity ($I^2 = 0\%$) (Fig. 2, Supplementary Table 4). A fifth paper reported a greater prevalence of obese individuals (defined as BMI ≥30) in the GTPS group (33%) compared to healthy controls (9%, $p = 0.019$, Relative Risk GTPS 0.66; 95%CI 0.48 to 0.90) (Fearon et al., 2013) but did not report mean BMI data for each group. Waist, hip, and greater trochanteric circumference were assessed using a non-elastic measuring tape in one study (Fearon et al., 2012). Greater hip circumference was shown in the GTPS group compared to controls (SMD 0.66; 95%CI 0.08 to 1.24), but no group differences were found for waist or greater trochanteric circumference (Fearon et al., 2012).

Two studies measured pelvic morphology using anterior to posterior radiographs (Fearon et al., 2012; Viradia et al., 2011). Large and moderate SMDs were found for inter-ASIS width (SMD 1.42; 95%CI 0.92 to 1.91; Allison et al., 2016a) and greater trochanteric width (overall SMD (n = 2) 0.98; 95%CI 0.71 to 1.25; $I^2 = 0\%$; Fig. 2, Supplementary Table 4; Viradia et al., 2011), and both measures were found to be significantly greater in individuals with GTPS. Iliac width, measured as the distance between the iliac wings on radiographs, was also significantly greater in 101 individuals with clinically diagnosed trochanteric bursitis compared to 101 controls (SMD 0.40; 95%CI 0.12 to 0.68) (Viradia et al., 2011). In addition, it was found that individuals with GTPS presented with a greater difference between the iliac width and the greater trochanter width (SMD 0.58; 95%CI 0.30, 0.86) (Viradia et al., 2011). Femoral neck shaft angle and acetabular angle were assessed in a study including females only (Fearon et al., 2012). No differences in femoral neck shaft angle or acetabular angle were found in the GTPS group compared to healthy controls. This study included a subgroup of GTPS with evidence of tendon tear on imaging plus symptoms refractory to corticosteroid injection and physiotherapy. Significant lower neck-shaft angle was shown for this subgroup compared to the healthy control group (< 134°: OR 3.33; 95%CI 1.26, 8.85; $p = 0.007$) (Fearon et al., 2012).

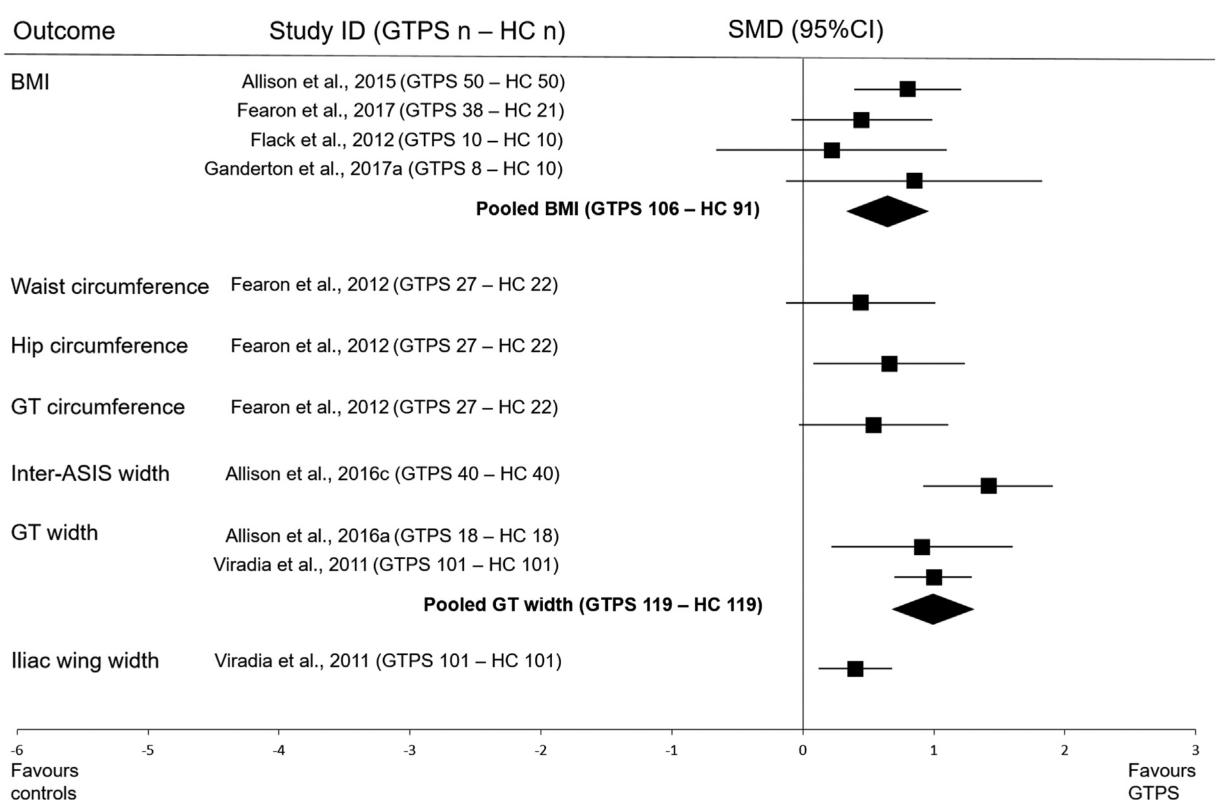

Fig. 2. Standard mean differences (SMD) between GTPS and healthy controls for Body Mass Index (BMI), waist, hip, and greater trochanteric (GT) circumference, inter ASIS width, GT width, and iliac wing width.

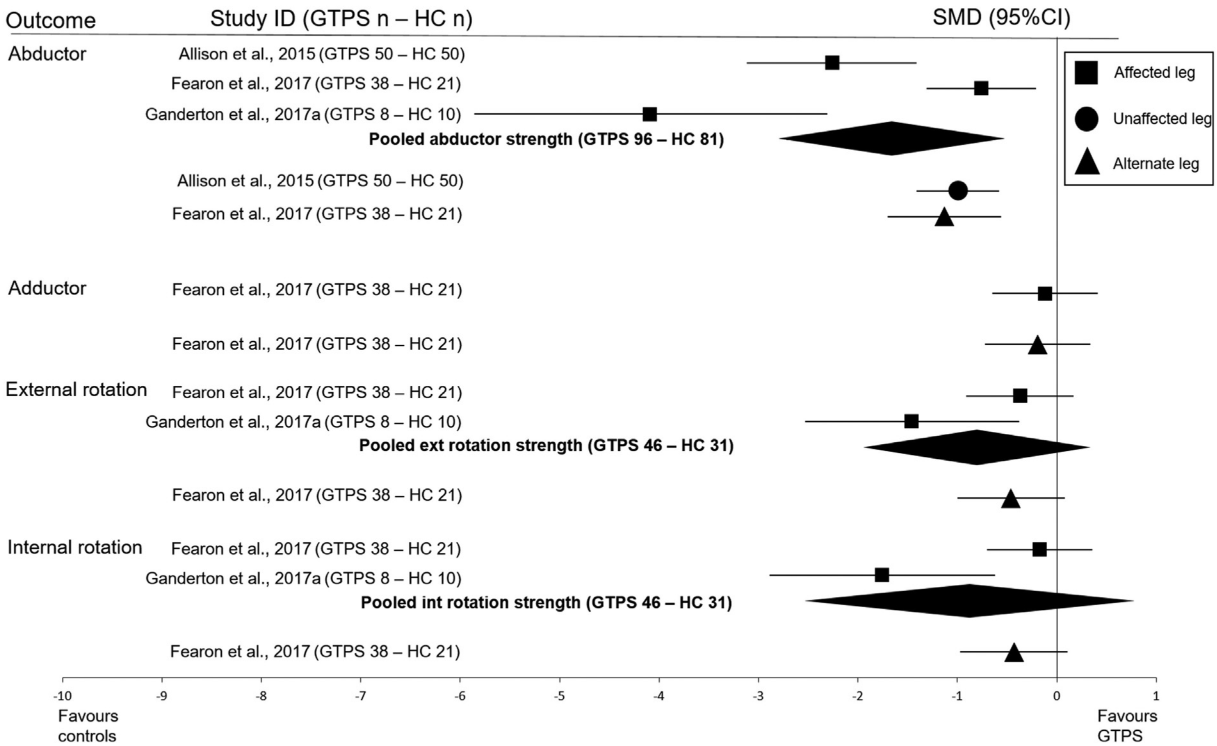

Fig. 3. Standard mean differences (SMD) of hip strength measures between GTPS and healthy controls. The squares represent hip strength measures of the affected side, circles the unaffected side, and triangles represent hip strength measures of the alternate side in participants with bilateral symptoms (Fearon et al., 2017).

3.6. Muscle properties

One paper reported muscle volume obtained from magnetic resonance imaging of the gluteus medius, gluteus minimus and the tensor fasciae latae (TFL) in ten females with unilateral lateral hip pain and ten female controls (Flack et al., 2012). No between group differences in muscle volume of the hip abductors was found between the symptomatic and asymptomatic sides (Supplementary Table 4) (Flack et al., 2012).

Isometric hip abductor strength was measured in four studies using a handheld dynamometer with the participant in supine (Allison et al., 2015, 2016a; Fearon et al., 2017) or side-lying (Ganderton et al., 2017a). Due to overlap in participants in two studies (Allison et al., 2015, 2016a), only data from Allison et al. (2015) was included. Three studies reported hip abductor muscle weakness on the affected side in individuals with GTPS compared to controls. Meta-analysis showed a large effect (overall SMD (n = 3) −1.67; 95%CI -2.72 to −0.62; I^2 = 85%, Fig. 3, Supplementary Table 4) (Allison et al., 2015; Fearon et al., 2017; Ganderton et al., 2017a). Fifty-five percent of GTPS participants in Fearon et al. (2017) presented with bilateral symptoms, whereas Allison et al. (2015) included participants with unilateral symptoms. Hip abductor weakness on the unaffected showed a moderate effect (SMD -0.99; 95%CI -1.41, −0.58) (Allison et al., 2015). No differences in adduction (Fearon et al., 2017), internal rotation (overall SMD (n = 2) −0.88; 95%CI -2.43 to 0.67; I^2 = 84%) or external rotation strength (overall SMD (n = 2) −0.81; 95%CI -1.86 to 0.24; I^2 = 68%; Fig. 3) were observed between groups (Fearon et al., 2017; Ganderton et al., 2017a).

Gluteus medius, gluteus minimus and TFL muscle activity during gait was investigated in two studies (Allison et al., 2017; Ganderton et al., 2017a). In one study, participants with GTPS showed a longer burst of muscle activity after heel strike compared to controls (Allison et al., 2017). In the other study, greater peak amplitude was reported in gluteus medius and gluteus minimus but not TFL during different phases of the gait cycle (Supplementary Table 4) (Ganderton et al., 2017a). These results should be interpreted with care when considering data normalisation methodology, where the linear envelopes were normalised to the maximum EMG signal recorded during the task (gait). Although this method accommodates task comparison, it is not a standard value that fits between group comparisons (for example maximum voluntary contraction) (Ganderton et al., 2017a).

3.7. Kinematics & kinetics

Five studies investigated kinematic and kinetic parameters during gait, stair ascent and single leg stance (Allison et al., 2016a, 2016b, 2016c; Fearon et al., 2017; Ganderton et al., 2017a). A significantly shorter step length and slower step velocity was reported in three studies (Allison et al., 2016c; Fearon et al., 2017; Ganderton et al., 2017a). The pooled SMD for step length was large, but with high heterogeneity (overall SMD (n = 2) −1.29; 95%CI -2.58, −0.01; I^2 = 91%) (Allison et al., 2016c; Fearon et al., 2017). Step velocity revealed a moderate SMD with low heterogeneity (overall SMD (n = 3) −0.72; 95%CI -1.05 to −0.39; I^2 = 0%) (Supplementary Fig. 1, Supplementary Table 4). Participants showed lower cadence during a 10 m walk test (Fearon et al., 2017), a greater timed up and go (Fearon et al., 2017), and a significantly greater single leg stance duration (Fearon et al., 2013, 2017).

During walking, the external hip adduction moment was greater in GTPS participants compared to controls during the entire stance phase with moderate to large SMDs (Supplementary Table 4) (Allison et al., 2016c). During the first peak of the external hip adduction moment, GTPS participants had less ipsilateral trunk lean compared to controls (SMD 0.59; 95%CI 0.15 to 1.04) (Allison et al., 2016c). Lateral trunk lean was expressed by the frontal plane angle of the trunk segment (defined by the sternum, C7 and T10 markers) in relation to the laboratory coordinate system (Allison et al., 2017). A greater contralateral pelvic drop (the contralateral pelvis is dropped relative to the stance limb) was observed in individuals with GTPS during the second peak of the external hip adduction moment (SMD 0.46; 95%CI 0.02 to

0.91). Together with findings of a study looking at GTPS participants ascending stairs (Allison et al., 2016b), these two studies demonstrated altered trunk and pelvic kinematics in individuals with GTPS (Supplementary Figs. 1 and 2) (Allison et al., 2016b, 2016c).

Another study assessed kinetics and kinematics during neutral stance, preparation for single leg stance and during maintained single leg stance (Allison et al., 2016a). Greater hip adduction angle and less contralateral pelvic rise (when the non-weight bearing side of the pelvis is elevated relative to stance side) was observed in the GTPS group during maintained single leg stance (Supplementary Fig. 3). Only the between group differences in pelvic shift in preparation for single leg stance remained when comparisons were controlled for hip abductor strength (Allison et al., 2016a). This means that individuals with GTPS place their feet 12% closer to pelvic midline (defined by the calcaneal marker) independent of hip abductor strength.

3.8. Psychosocial features

Quality of life was measured in one study by the Assessment of Quality of Life instrument (Hawthorne and Osborne, 2004). Lower quality of life was reported in individuals with GTPS compared to healthy controls (Fearon et al., 2014a). No studies investigating psychological characteristics between individuals with GTPS and healthy controls were identified.

4. Discussion

This systematic review aimed to improve our understanding of the physical and psychosocial features of individuals with GTPS compared to healthy controls and to estimate the magnitude of observed differences where possible. Greater pelvic (inter – ASIS, iliac wing) and femoral (greater trochanter) width, greater BMI, hip abductor muscle weakness, higher hip abductor activity, altered single leg loading and gait parameters were observed in participants with GTPS compared to controls. The overall certainty of evidence after applying the GRADE approach was very low. We did not identify studies looking at psychological or sensory characteristics in individuals with GTPS compared to healthy controls.

Individuals with GTPS had significantly greater BMI and greater hip circumference compared to healthy controls (Fearon et al., 2012). Meta-analysis identified moderate differences in BMI, consistent with findings from the largest of the four studies included in this systematic review (Allison et al., 2015). Previous systematic reviews have reported an association between gynoid adiposity (measured by BMI and circumference measures) and other tendinopathies (Franceschi et al., 2014; Scott et al., 2015). The relationship of higher BMI and tendon health has been proposed to occur through excessive mechanical load on tendon tissues (Gaida et al., 2009; Magnusson et al., 2010; Scott et al., 2015) and/or elevated pro-inflammatory cytokines of tendon pathology (Ackerman et al., 2017; Park et al., 2005). Elevated pro-inflammatory cytokine levels may compromise tendon load bearing capacity and contribute to a failed healing response (Biancalana et al., 2010; Gaida et al., 2009; Park et al., 2005). Excessive load through a tendon previously compromised by metabolically disturbed tenocytes could plausibly predispose to injuries in asymptomatic individuals (Park et al., 2005).

GTPS was associated with altered kinematics during single leg loading tasks and walking (Allison et al., 2016a, 2016b, 2016c). A greater external hip adduction moment was found throughout the stance phase of walking (Allison et al., 2016c), together with a greater hip adduction angle in preparation for and during single leg stance (Allison et al., 2016a). Excessive adduction and longer bursts of muscle activity may increase compression of the gluteal tendons at the greater trochanter and contribute to the continuation and/or the development of GTPS (Cook and Purdam, 2012). Further, greater hip adduction angle co-varied with hip abductor muscle strength (Allison et al., 2016a). The above findings suggest that altered movement patterns and muscle weakness are associated with abnormal loading of the gluteal tendons during single leg loading in individuals with GTPS (Cook and Purdam, 2012; Cook et al., 2016).

Though at this stage no causal inference can be made, identified impairments in loading, movement and muscle strength could plausibly be addressed in clinical practice by a combination of education and exercise. The education should be focused on reducing pain-provocative hip-adducted postures during commonly adopted positions (e.g., avoid sitting cross legged) and activities (e.g., placing foot in midline during stair climbing) (Grimaldi and Fearon, 2015; Grimaldi et al., 2015). This recommendation is consistent with findings from a recent clinical trial looking at education plus exercise focused on load management, which found the education plus exercise group to have a greater improvement compared corticosteroid injection or a wait and see approach in the short term and long term (Mellor et al., 2018). Abductor strength was significantly better at 8 weeks in the education plus exercise group compared to wait and see at eight weeks (Mellor et al., 2018). Progressive strengthening of the hip abductor muscles may improve tendon capacity to bear load, potentially leading to normalisation of kinematics (Grimaldi et al., 2015; Rio et al., 2015). Further research is required.

The findings of this systematic review identified a significant gap in the literature in relation topsychosocial measures in individuals with GTPS. With the exception of quality of life measures, no other aspect of psychosocial function has been investigated in GTPS. The importance of identifying psychosocial features in individuals with persistent musculoskeletal pain (Bener et al., 2013; Das De et al., 2013) and their influence on treatment outcomes has become increasingly emphasized (Hill et al., 2008, 2011). Evidence from studies in other tendinopathies has shown associations between depression and lateral elbow tendinopathy (Alizadehkhaiyat et al., 2007; Garnevall et al., 2013), pain catastrophizing and upper limb rotator cuff tendinopathy (Kromer et al., 2014), and greater psychological burden during daily and highly valued activities and Achilles tendinopathy (Mc Auliffe et al., 2017). In addition, Silbernagel et al. (2011) suggested that kinesiophobia may have a negative impact on the effectiveness of treatment in Achilles tendinopathy, further emphasizing the importance of the possible role of psychological features on outcomes (Silbernagel et al., 2011).

Data from cross sectional studies was synthesised to determine whether differences between individuals with GTPS and healthy controls existed and to estimate the magnitude of those differences. Included studies had a moderate methodological quality with small sample sizes that were female biased and heterogeneous across clinical diagnosis, outcome measure assessment methodology, and the reporting of GTPS symptom chronicity and severity. The overall certainty of evidence of outcomes measured in two or more studies was considered very low, after applying the GRADE approach. Thus, further research is likely to impact on our confidence in the conclusions made in the current study. Cross sectional study designs limit causal inferences. It is not known if reported impairments are precursors to or resultant from the presence of GTPS. There is a need for sufficiently powered longitudinal studies, preferably using similar outcome measures to allow meta-analyses. Future research should focus on the possible influence of psychological and sensory features in individuals with persistent GTPS.

5. Conclusions

We conclude from a small number of cross-sectional studies that greater trochanteric width, greater BMI, hip abductor muscle weakness, altered hip abductor activity, altered single leg loading and gait parameters are features associated with GTPS compared to healthy individuals. The overall quality of the evidence was very low across studies. Additional, and higher quality methodology and study designs are required to address those limitations.

Declarations of interest

None.

Ethical approval

Not applicable.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.msksp.2019.07.009.

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