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Original Article

Correlates of localized musculoskeletal pain in overweight female health care professionals

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Abstract

Objectives: The risk of musculoskeletal pain increases when there is an imbalance between work demands and physical capacity. Work in elder care requires frequent periods of high mechanical loading. Body weight can further amplify this load, while muscle strength may lessen the relative strain on the musculoskeletal system. The purpose of this study was to assess the correlation between body composition, muscular strength and localized musculoskeletal pain intensity in overweight female health care professionals. **Methods**: A sample of 139 overweight female health care professionals working in elder care were included in the analyses. Associations between BMI, fat percentage, waist circumference, muscle strength and localized pain intensity were assessed using Kendall's rank correlation. **Results**: Significant associations were found between musculoskeletal pain in the right shoulder and BMI (r_τ=0.194; p=0.035), whereas upper back pain was associated with fat percentage and waist circumference (r_τ=0.212; p=0.023 and r_τ=0.212; p=0.024, respectively). **Conclusions:** Results indicate high BMI, fat percentage, and waist circumference may be contributing factors of localized musculoskeletal pain intensity of the upper body in overweight female health care professionals. These results may help guide the design of future workplace health promotion programmes.

Keywords: Body mass index, Fat percentage, Muscle strength, Obesity, Workplace Health Promotion

Introduction

Musculoskeletal pain is affecting up to 47% of the general population[1] and is costly to both employers and health care systems due to increased absenteeism, presenteeism, and treatment costs[2,3]. Health care professionals are at elevated risk of developing musculoskeletal pain, particularly in the lower back, with a prevalence exceeding many other high-risk job types[4,5]. Musculoskeletal pain of health care professionals in elder care can most likely be attributed to patient handling often including lifting, pushing, and pulling in awkward position as well as non-neutral and repetitive motion patterns, which places high force demands on the musculoskeletal system[4,6-9]. A study by Christensen et al. from 2015 found an association between body composition, muscle strength and presenteeism for health care workers[10]. The risk of musculoskeletal pain increases when there is an imbalance between work demands and physical capacity[6]. Thus, having greater muscle strength may protect against musculoskeletal pain by increasing the resilience to external loading on joint and muscles[6,11].

The authors have no conflict of interest.

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Additionally, high body mass would increase the energy expenditure and total load on the musculoskeletal system during tasks requiring bodily movement.

While numerous studies have examined the link between muscle strength and localized pain in the working population[12-17], to the best of our knowledge, this is the first study to explore the association between muscle strength, body composition and localized pain intensity in overweight female health care professionals. Therefore, the objective of the present study was to examine the association between localized musculoskeletal pain and body mass index (BMI), fat percentage, waist circumference, as well as muscle strength in overweight female health care professionals. We hypothesized that: (i) BMI and fat percentage would be positively correlated with pain in the shoulders, upper back, and lower back and (ii) muscle strength in the shoulders, upper and lower back would be negatively correlated with pain intensity in each respective body region.

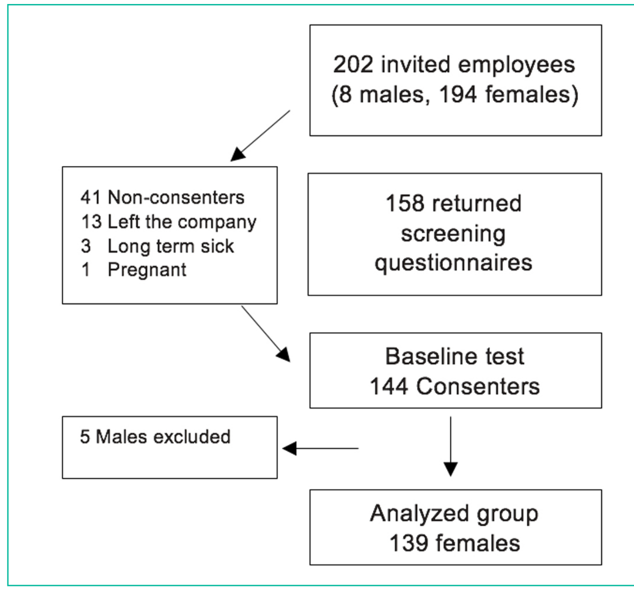

Figure 1. Flow of participants included in analyses.

Methods and materials

Study design

This study utilizes baseline data from the FINALE-Health project. FINALE-Health was a cluster randomized, single-blinded, controlled trial conducted between May 2009 and June 2010[18]. The effects of the intervention on health-related outcomes[18] have previously been reported along with effects on presenteeism and absenteeism[10,19]. The FINALE-Health study was ethically approved by The Central Denmark Region Committees on Biomedical Research Ethics (M-20090050) and registered at ClinicalTrials.gov (NCT01015716).

Participants

The study procedure has been reported elsewhere in detail[18]. Briefly; overweight female health care professionals working in elder care in Randers municipality (DK) were invited to participate in the study. Inclusion criteria were (1) female gender, (2) working with elder care as primary work task and (3) being overweight (defined as having a BMI >25 or fat percentage of >33% (18-40 years) or >34% (>40 years))[20]. Baseline data was available for 139 workers. A flow chart of the recruitment procedure is available in Figure 1. The study sample consisted of 87.7% health care workers and 12.3% other personnel (occupational therapists, physiotherapists and nurses) as baseline data was not statistically significantly different based on vocation, all were included in the final analysis.

Physical capacity and anthropometry

The utilized test procedures have previously been described in detail[18]. In short, during a single test session, muscle strength was measured as isometric maximal voluntary contractions during shoulder elevation, shoulder abduction, spine flexion, and spine extension using a

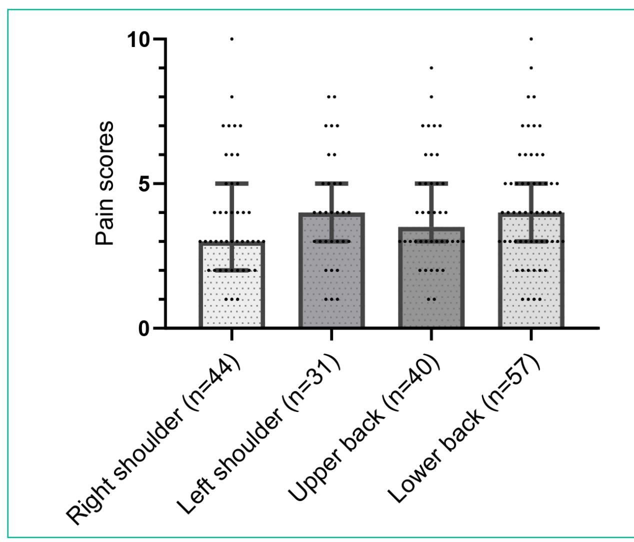

Figure 2. Distribution of localized pain severity and location. Bars indicate median scores, lines are interquartile range, dots indicate individual values, n are number of participants.

reproducible standardized setup[21-23]. Participants were excluded from strength testing if performing the test invoked severe pain.

Questionnaires

A questionnaire was administered one week prior to the test session. The questionnaire included 140 questions regarding background, habits, musculoskeletal pain,

	N	Mean	SD
Age (years)	139	45.4	9.5
Height (cm)	132	165.5	6.1
Weight (kg)	132	77.4	17.0
Body mass index (kg/m^2)	128	28.2	5.8
Waist circumference (cm)	129	94.6	15.2
Fat percentage (%)	132	37.3	7.9
Back flexion (Nm)	73	121.5	37.6
Back extension (Nm)	72	113.3	36.9
Right Shoulder elevation (Nm)	69	67.2	22.5
Left Shoulder elevation (Nm)	70	59.1	21.1
Right Shoulder abduction (Nm)	70	32.8	12.3
Left Shoulder abduction (Nm)	69	33.2	11.5
N=Number of valid observations, SD=Standard deviation.			

Table 1. Participant Characteristics.

	Right shoulder pain N=65	Left shoulder pain N=54	Upper back pain N= 66	Lower back pain N=79
Body mass index	0.194 (0.035*)	0.109 (0.289)	0.142 (0.130)	0.127 (0.120)
Fat percentage	0.168 (0.067)	0.123 (0.229)	0.212 (0.023*)	0.128 (0.117)
Waist circumference	0.151 (0.102)	0.106 (0.303)	0.212 (0.024*)	0.107 (0.193)
*N=Number of valid observations, SD=Standard deviation, *statistically significant correlation (p>0.05).*				

Table 2. Associations between anthropometric measures and localized pain intensity.

presenteeism, absenteeism, and physical activity[18,24]. Musculoskeletal pain was assessed using the Standardized Nordic Questionnaire of Musculoskeletal Disorders[25], supplemented with questions about localized pain intensity measured on a 10-point Likert scale with 0 indicating 'no pain at all' and 10 indicating 'the worst possible pain'.

Statistical analysis

Per-protocol analyses were performed using data only from participants who fulfilled the protocol in terms of outcome assessment (i.e. completed the test session for the specific outcome). Variations in amount of data for specific outcomes are observed across analyses. The analyses of the association between different measures of body composition, muscle strength and intensity in musculoskeletal pain for all measured body regions were conducted using Kendall's rank correlation. Only participant with a pain score >0 was considered for correlational analyses. Group comparisons were performed using non-parametric statistics as appropriate. All analyses were performed using software package STATA 14.2 (StataCorp, College Station, Texas). A p value of <0.05 was considered statistically significant.

Results

Table 1 presents the demographic characteristics of the sample. As there was no statistically significant difference based on grouping (intervention vs. control, p>0.05), data were pooled for both groups.

A total of 87 (62.5%) of respondents reported having felt some degree of pain in either the right or left shoulder or the upper or lower back within the last week. Median pain scores for each body region are available in Figure 2.

Pain intensity and body composition

Table 2 presents the association between localized musculoskeletal pain and body composition. A significant association was found between musculoskeletal pain in the right shoulder and BMI (p=0.035). Further, significant

Correlations between body part specific strength measures and localized pain intensity				
Muscle strength	Right shoulder pain	Left shoulder pain	Upper back pain	Lower back pain
Shoulder elevation, right	0.0612 (0.6380) N=36	00.0029 (1.000) N=29	0.1028 (0.4424) N=34	0.1625 (0.1517) N=44
Shoulder elevation, left	-0.0677 (0.5947) N=37	-0.0616 (0.6759) N=30	-0.0018 (1.000) N= 34	0.1612 (0.1508) N=44
Shoulder abduction, right	0.0539 (0.6678) N=38	-0.0698 (0.6347) N=30	0.0651 (0.6298) N=34	0.1414 (0.2131) N=44
Shoulder abduction, left	-0.0416 (0.7462) N= 37	-0.1394 (0.3324) N=30	0.0430 (0.7584) N=33	0.1003 (0.3846) N=43
Back extension	0.0272 (0.8343) N=38	-0.1631 (0.2427) N=31	0.0601 (0.6529) N=35	0.0460 (0.6873) N=45
Back flexion	-0.2304 (0.0579) N=39	-0.1613 (0.2498) N= 31	-0.1404 (0.2764) N=36	0.0202 (0.8642) N=45
Data are Tau-b values (p values). N is the number of valid observations for each outcome.				

Table 3. Associations between body part specific strength measures and localized pain intensity.

associations were found between musculoskeletal pain in the upper back and fat percentage (p=0.023) as well as upper back and waist circumference (p=0.024).

Pain intensity and muscle strength

In this sample no association between muscular strength were found for any measure of localized musculoskeletal pain (all p>0.05) (Table 3). Not all participants completed all measures of isometric strength testing. Missing data constituted between 46.32 and 49.26% for all measures of muscle testing with back flexion and shoulder abduction (left) having the lowest and highest degree of missingness, respectively. Right shoulder pain was higher in cases with missing data on right shoulder elevation (median pain-score: missing cases: 4.0; complete cases: 3.0, p=0.015) and right shoulder abduction (median pain-score: missing cases: 3.5; complete cases: 3.0, p=0.049). Similarly, low back pain was higher in cases with missing data on lower back flexion (median pain-score: missing cases: 5.0; complete cases: 4.0, p=0.046) and extension (median pain-score: missing cases: 5.0; complete cases: 4.0, p=0.046).

Discussion

The present study found a positive correlation between musculoskeletal pain of the right shoulder and BMI. Also, fat percentage and waist circumference were positively correlated with musculoskeletal pain in the upper back.

In this sample of overweight female health care professionals having high BMI was found to be associated with increased intensities of musculoskeletal pain of the right shoulder. Similar findings have been reported for other populations were BMI have been found to be associated with overall musculoskeletal pain[26], increased prevalence of multisite musculoskeletal pain[27-29], and pain in specific body regions including knees, limbs, lower back, neck, and shoulders[17,26,27]. These studies have examined the general population[17,27,29], housewives[26], and female kitchen workers28. The present study includes overweight female health care professionals working with elder care. Working in elder care requires long periods of standing and working in awkward postures and involves a large amount of manual work tasks with high peak force[30]. We propose that the correlation seen with BMI and right shoulder pain may be an effect of vocational exposures where especially resident/patient handling and transfer requires a high amount of forward reaching. High body mass (especially of the upper limbs) would increase the mechanical load during forward reaching (i.e shoulder flexion) and as such the strain on the shoulder girdle. That this finding was only significant for the right shoulder is likely due to the right arm being utilized more, as this was the dominant limb for the vast majority of the sample. The left hand (and shoulder) would instead primarily be used for support during handling and transfer activities. Moreover, as a high BMI indicates a high body volume relative to height, this could in itself increase reaching distances when, for instance, reaching over a patient, either due to the shortness of limbs or obstruction provided by the size of the torso.

The correlation between fat percentage, waist circumference and upper back pain may similarly be related to vocational exposure. However, as every participant was female, increased fat percentage would also significantly increase breast weight which have previously been shown to increase the risk of upper back pain[31,32].

Previous findings support an association between musculoskeletal pain in the upper back and fat percentage as well as waist circumference. In a study examining the general population, Brady et al. found that greater fat mass was associated with pain in more body regions, independent of fat-free mass[27]. Further, Urquhart et al. found greater fat mass, but not lean tissue mass, to be associated with higher pain intensity[33]. Brady et al. argues that although obesity must be considered a risk factor for musculoskeletal pain, a growing amount of evidence suggests that this is not simply caused by physical loading and higher levels of force on the musculoskeletal system[27]. Another possible mechanism by which obesity may increase pain is through increased pain sensitivity due to systemic inflammation associated with severe adiposity[34]. This hypothesis is supported in findings by Cicuttini et al. who found obesity to be a risk factor for pain resulting from osteoarthritis in the hands, which is not affected by higher physical loading due to obesity[35].

The present study found no association between musculoskeletal pain and muscle strength. Other studies have examined maximal voluntary contraction of shoulder and neck muscles among females with musculoskeletal disorders compared to healthy females. These studies found females with musculoskeletal disorders (including pain) to have lower maximal voluntary contraction compared to healthy controls[36-39]. Likewise, several studies have found strength training to decrease pain in lower back, spine, neck, and upper extremities in various populations[12-17], the lack of any association between muscle strength and pain severity in the present study was surprising, but is likely related to the amount of missing data. Incomplete cases constituted approximately 47% for all muscle function tests. In addition, missing MVC data on right shoulder elevation, right shoulder abduction, back flexion and back extension was determined as associated with higher pain scores for that specific body part (i.e: right shoulder and lower back). This indicates that pain influenced the validity of the test, causing a selection bias, with participants most affected by pain not completing all tests. Therefore, these results should be interpreted with caution.

Practical implications

Taken together, the results presented in this study indicates a relationship between body mass, fat mass and pain intensity.

These results lends credence to the notion that workplace health promotions programmes should be tailored to the needs of the target population i.e., weight loss programmes for overweight individuals, strengthening excercise for individuals with low physical capacity relative to work demands ect. This is in line with our previously proposed Intelligent Physical Excercise Training (IPET) scheme[40]. As reported in a previous publication, women working within health care may be especially prone to poor dietary behavior[41]. Therefore, health promotion programmes targeting this population should include outcomes related to nutrition. The IPET scheme have already been demonstrated as effective in this population, leading to clinically significant reductions in fat percentage and BMI[42]. Moreover, In a recently publicized survey of 382 Danish leaders in eldercare, we were able to show very high willingness to implement IPET-based interventions in eldercare[43]. Thus, eldercare seems an obvious arena for future implementation of health promotion programmes.

Data is presented unadjusted; therefore, we cannot rule out the potential influence of confounders (e.g. medication or disease history). However, as this was a specific sample containing only overweight female employees and since participants with pre-existing medical conditions were excluded[18], the influence of unadjusted covariates is most likely largely inconsequential. Moreover, the identified significant correlations would no longer be significant if a simple Bonferroni adjustment was applied to correct for the number of hypotheses tested (α-level; 0.05/4=0.00125)[44]. While the Bonferroni method have been criticized for being too restrictive[45], the lack of highly significant findings despite the multiple analyses performed does limit the certainty ascribable to the present results. While reasonable explanations are available for all findings, such findings could result from random chance. In addition, the present study only presents cross-sectional data and cannot infer causality. However, previous findings support the link between vocational exposure and musculoskeletal pain[46,47], patient handling does involve large amount of forward reaching[9], work-related force requirements in the arms and neck have previously been shown to correlate with shoulder pain[48] and increased over-all body weight would logically increase the strain on the musculoskeletal system (e.g. the shoulder girdle during shoulder flexion). Thus, taken together with the present results, the concomitant indication supports that body composition may be an important mediator of localized muscle pain due to work exposure. Future studies on effective workplace health promotion in elder care may benefit from including outcomes related to body composition. More research is needed to investigate how changes in body composition may impact musculoskeletal pain due to work exposure in elder care.

Conclusions

The present study found a positive association between higher musculoskeletal pain in the right shoulder and BMI. Significant associations were found between higher musculoskeletal pain in the upper back and fat percentage as well as waist circumference. The results indicate that higher BMI, fat percentage, and waist circumference may be contributing factors for musculoskeletal pain in the upper body. This may especially be relevant during patient handling and transferring, in awkward positions and with high peak force. Future workplace health promotion programmes targeting obese female health care professionals may benefit from programmes aimed at reducing BMI, fat percentage and waist circumference, as this could potentially alleviate localized pain intensity.

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