

# Obesity-related chronic lymphoedema-like swelling and physical function

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Received 22 March 2014 and in revised form 20 July 2014

## Summary

**Background:** People with severe obesity (body mass index [BMI] > 40 kg/m<sup>2</sup>) have an 85% higher mortality than people with a healthy BMI. Poor physical function may contribute to this excess mortality. Lymphoedema-like swelling can affect the legs of severely obese people with normal lymphoscintigraphy.

**Aim:** We sought to determine the relationship between the presence of lymphoedema-like swelling and physical function in the severely obese.

**Design and Methods:** In people with severe obesity, we ascertained whether lower leg lymphoedema-like swelling was present and determined the circumference of the lower leg, time taken to ascend and descend a 17-cm step 50 times and time taken to walk 500 m.

**Results:** The 330 participants, 33% of whom were male, were aged 43.4 ± 12.7 years (mean ± standard deviation) and had a BMI of 51.7 ± 8.4 kg/m<sup>2</sup>. Lymphoedema-like swelling was present in

approximately one-third ( $n=108$ ) in whom a prior history of cellulitis and venous thromboembolism was more common (relative risks 6.16 and 3.86, respectively) than in those without lymphoedema-like swelling. Participants with lymphoedema-like swelling, compared with non-affected counterparts, had a higher lower leg circumference ( $35.0 \pm 7.1$  vs.  $32.4 \pm 4.8$  cm), a slower step speed ( $0.40 \pm 0.12$  vs.  $0.43 \pm 0.10$  steps/s) and a slower walking speed ( $0.97 \pm 0.37$  vs.  $1.08 \pm 0.30$  m/s,  $P < 0.05$  for all comparisons).

**Conclusions:** In this cross-sectional study, 33% of our severely obese participants had lymphoedema-like swelling. Participants with lymphoedema-like swelling had worse physical function than those without. This association was independent of BMI. The presence of obesity-related chronic lymphoedema-like swelling should lead to interventions that improve physical function.

## Introduction

Severe obesity (body mass index [BMI] > 40 kg/m<sup>2</sup>) affects 1.9% of Irish adults,<sup>1</sup> 2.7% of English adults<sup>2</sup> and 6.5% of American adults,<sup>3</sup> and it confers an 85% increase in mortality (risk of death over a given period of time).<sup>4</sup>

Individuals with severe obesity are eight times more likely to have suboptimal physical function than people with a healthy BMI.<sup>5</sup> People with

lower physical function scores have reduced quality of life and elevated mortality.<sup>6</sup> Physical function is assessed routinely in people attending our hospital-based weight management service.

Obesity has effects on skin barrier function, lymphatic function, collagen function, wound healing, microcirculation and macrocirculation,<sup>7</sup> which may explain the increased propensity for obese people to develop cellulitis.<sup>8</sup> Lymphoedema-like

swelling can affect the legs of people with severe obesity despite normal lymphoscintigraphy.<sup>9</sup> We thought it possible that abnormal lymphatic and/or venous drainage in severely obese people could impact limb movement and affect physical function.<sup>10</sup>

We sought to determine the relationship between lymphoedema-like swelling and physical function in people with severe obesity. We hypothesized that physical function is worse in those with obesity-related chronic lymphoedema-like swelling (ORCLLS) than in their non-affected counterparts.

## Materials and Methods

### Study population

We recruited prospectively all people aged 18–75 years during their initial attendance to our service during the months between August 2010 and January 2012 inclusive. Our service receives referrals from all over Ireland, and the only criterion for referral acceptance is a BMI >40 kg/m<sup>2</sup>. We excluded only people using a mobility aid and those in receipt of compression therapy.

The presence of leg swelling consistent with lymphoedema was determined by inspection by a study investigator (Figure 1). Informed consent was obtained from all participants and the study protocol was approved by the St Vincent's Healthcare Group Ethics and Medical Research Committee.

### Assessments

Medical and lifestyle information was collected using a standard proforma. Height and weight were measured, to the nearest 0.5 cm and 0.1 kg, respectively, while the participant was standing erect, wearing shoes, using an electronic stadiometer and an electronic scales (both from Seca, Hamburg, Germany). Supramalleolar circumference was measured, to the nearest 0.5 cm, 10 cm proximal to the most distal palpable point of the medial malleolus using a tape measure (Mabis, IL) without applying tension.

Physical function was assessed whether the participant was willing to undergo this assessment and had no contraindications to exercise. We recorded the time taken to walk around a 500-m mapped-out path and the time taken to ascend and descend 50 times a single step, which was 17 cm in height. Participants were instructed to exert themselves to a level they found 'slightly challenging' or to less than point 6 on a 10-point Borg Rating of Perceived Exertion (RPE).<sup>11</sup>

### Statistical analysis

All statistical analyses were performed using Version 20 of the PASW Statistics software package (IBM, IL). Continuous variables were compared in participants with and without ORCLLS using the independent samples *t*-test and, to adjust for age, BMI, gender and chronic illness, analyses of covariance. Dichotomous variables were compared using the chi-squared test and, to adjust for possible confounders, multivariate logistic regression analyses. No attempt was made to adjust for missing data. The level of statistical significance was set at <0.05 for all analyses.

### Results

We recruited 324 people with severe obesity whose age was 43.2 ± 12.5 years (mean ± standard deviation) and whose BMI was 51.6 ± 8.4 kg/m<sup>2</sup>. People excluded from this study made up <5% of all people who attended our service and their age was not significantly different from study participants, although their BMI was greater (Supplementary Table S1, see online supplementary material). The medial malleolus was palpable in all study participants. One-third of the participants were male (Table 1). Of the participants who were willing to undergo physical function testing, the 50-step test could not be completed by 35.1% and 19.6% were unable to walk 500 m (Table 1).

Participants with leg swelling were older, had a higher BMI and were more likely to use loop diuretic therapy than their non-affected counterparts (Table 1 and Supplementary Table S2). There were no differences in the prevalences of smoking, diabetes, ischaemic heart disease, varicose veins or use of medications that could affect leg swelling and/or physical function (Table 1 and Supplementary Table S2). Lower limb symptoms were more prevalent (relative risk [RR] 1.79), mean supramalleolar circumference was 10% higher and a prior history of cellulitis and venous thromboembolism was more common (RR 5.88 and 3.53, respectively) in participants with leg swelling than in those without (Table 1). The mean step speed and walking speed were 13.6% and 21.2% lower among those with leg swelling (Table 1).

### Discussion

In this study, physical function was worse in people with ORCLLS than in unaffected people of similar age and BMI. Participants with leg swelling (33% of the participants) had also a greater likelihood of



**Figure 1.** ORCLS—photographs of study participants illustrating the following: (a) peau d'orange, (b) cobblestoning, (c) mild peau d'orange with mild ankle cuffing, (d) erythema and ankle cuffing, (e) varicose eczema and (f) erythema.

lower leg symptoms, a greater prevalence of cellulitis and venous thrombosis and had lower physical activity levels than did those without. This is the largest study to have evaluated lymphoedema-like swelling in the severely obese.

The limitations of this study include lack of an objective method to diagnose lymphoedema-like swelling, a possible inability to generalize the data captured and the use of indirect measures of limb volume and physical function. Greene *et al.*<sup>9</sup> have shown previously that lymphoscintigraphy is commonly normal in severely obese people with lymphoedema-like swelling. More than 95% of research participants were white—whether

similar results would be found in other ethnic groups remains to be determined. Other investigators have found that circumferential measurements, using bony landmarks, correlate well with limb volume.<sup>12</sup> We chose to use self-paced step and walking tests as these compare well with physical function and mortality.<sup>6</sup> Self-paced walking tests have been used previously to assess physical function in people with severe obesity.<sup>13</sup>

Our findings are in keeping with those of the existing literature. Others have found a high prevalence of leg swelling (>50%) in people with severe obesity.<sup>14</sup> Similarly, others have found that those with obesity are more prone to cellulitis<sup>8</sup> and venous

**Table 1** Participant characteristics

Parameter	N	ORCLLS present (n=102)	ORCLLS absent (n=222)	All participants (n=324)	P-value <sup>a</sup>	P-value <sup>b</sup>	P-value <sup>c</sup>
Age (years)	324	46.4 ± 11.3	41.7 ± 12.8	43.2 ± 12.5	0.002		
BMI (kg/m <sup>2</sup> )	324	54.1 ± 9.5	50.4 ± 7.6	51.6 ± 8.4	<0.001		
Male	324	36 (35.3)	69 (31.1)	105 (32.4)	0.452		
Diabetes	314	24 (24.5)	38 (17.6)	62 (19.7)	0.155	0.433	
Chronic illness	324	80 (78.4)	163 (73.4)	243 (75.0)	0.334	0.728	
Prior VTE	324	13 (12.7)	8 (3.6)	21 (6.5)	0.002	<b>0.031</b>	<b>0.034</b>
Prior cellulitis	319	36 (35.3)	13 (6.0)	49 (15.4)	<0.001	<b>&lt;0.001</b>	<b>&lt;0.001</b>
LL symptoms	324	93 (91.2)	113 (50.9)	206 (63.6)	<0.001	<b>&lt;0.001</b>	<b>&lt;0.001</b>
SC (cm)	323	35.6 ± 7.1	32.1 ± 4.8	33.2 ± 9	<0.001	<b>&lt;0.001</b>	<b>0.009</b>
SC ≥ 35 cm	323	46 (45.5)	57 (25.7)	103 (31.9)	<0.001	<b>0.009</b>	<b>0.009</b>
Step speed (step/s)	310	0.38 ± 0.12	0.44 ± 0.10	0.42 ± 0.11	<0.001	<b>0.008</b>	<b>0.023</b>
Fifty steps completed	313	49 (50.0)	154 (71.6)	203 (64.9)	<0.001	<i>0.072</i>	<i>0.074</i>
Completer step speed (steps/s)	203	0.44 ± 0.09	0.47 ± 0.09	0.46 ± 0.09	0.019	0.151	0.243
Walking speed (m/s)	311	0.89 ± 0.38	1.13 ± 0.30	1.05 ± 0.34	<0.001	<b>0.002</b>	<b>0.003</b>
Able to walk 500 m	316	67 (67.7)	187 (86.2)	254 (80.4)	<0.001	0.157	0.175
Completer walking speed (m/s)	254	1.09 ± 0.23	1.20 ± 0.22	1.17 ± 0.22	0.001	<b>0.013</b>	<b>0.035</b>
Activity level (min/week)	222	65.9 ± 108.6	120.3 ± 163.8	104.4 ± 151.6	0.015	<i>0.053</i>	<b>0.027</b>

Data are expressed as mean ± standard deviation or as number (percentage).

BMI, body mass index; LL, lower leg; N, number of participants for whom data were available; ORCLLS, obesity-related chronic lymphoedema-like swelling; SC, supramalleolar circumference; VTE, venous thromboembolism.

<sup>a</sup>P-values were calculated using the independent samples *t* test or chi-squared test. <sup>b</sup>P-values were calculated using analyses of covariance and multivariate logistic regression analyses adjusting for age, BMI and gender. <sup>c</sup>P-values were calculated using analyses of covariance and multivariate logistic regression analyses adjusting for age, BMI, gender and chronic illness.

Values in bold highlight a value less than 0.05 in the second and final statistical models. Values in italics highlight a value between 0.05 and 0.1 in the second and final statistical models.

thromboembolism.<sup>15</sup> Although the post-thrombotic syndrome is described well,<sup>15</sup> we can find no studies showing a link between leg swelling and previous cellulitis. In the same way, although other investigators have noted a relationship between obesity with physical function,<sup>5</sup> none have related lymphoedema-like swelling in the severely obese to physical function.

Taken together, the findings suggest that lymphoedema-like swelling contributes to physical dysfunction in the severely obese. It may be that excess adipose tissue makes dermal lymphatic vessels dysfunctional. The statistical analyses performed show that this relationship is independent of BMI (and of age, gender and chronic illness). Treatment of suboptimal skin drainage may improve physical function and thereby decrease mortality—appropriately powered trials are required to evaluate rigorously this possibility.

We conclude that lymphoedema-like swelling is common among people with severe obesity, and its presence confers a high risk of physical dysfunction. We feel that its presence should be a portal to

interventions that improve physical function and that its management is likely to yield clinical benefit.

## Supplementary material

Supplementary material is available at *QJMED* online.

## Acknowledgements

Aside from funding the supporters had no role in study design, study conduct or manuscript preparation. E.O.M. and T.A. had full access to, and control of, all the data in the study and take responsibility together for the integrity of the data and the accuracy of the data analysis.

## Funding

This work was supported partially by the Health Research Board of Ireland (HPF/2010/37 to T.A.) and by the Irish Heart Foundation (0993704 to T.A.).

Conflict of interest: None declared.

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