

The Effects of Obesity on Orthopaedic Foot and Ankle Pathology

Carol Frey, M.D.; James Zamora, M.D.
Manhattan Beach, CA

ABSTRACT

Background: It is believed that obese individuals may have an increased number of foot and ankle problems. The World Health Organization recommends a standard classification of adult overweight and obesity using the following body mass index (BMI) calculations: a BMI of 25.0 to 29.9 kg per m^2 is defined as overweight; a BMI of 30.0 kg per m^2 or more is defined as obesity. The purpose of this paper was to report a survey of 1411 patients in an orthopaedic foot and ankle practice and compare the incidence of orthopaedic foot and ankle complaints with the BMI. **Method:** One thousand four hundred and eleven adults, including 887(62.4%) women and 535(37.6%) men, were evaluated in this study. The BMI was calculated for each subject using the standards of the World Health Organization. The subjects were divided into two groups: normal and overweight. The normal weight subjects had a BMI of 18.5 to 24.9 ($n = 684$; 48.1%) and the overweight or obese group had a BMI greater than or equal to 25 ($n = 738$; 51.9%). **Results:** In this study, being overweight or obese significantly increased the chances of having tendinitis in general. If the subjects were overweight or obese, there was an increased likelihood, although not significant, of plantar fasciitis and osteoarthritis. If the individuals were of normal weight, there was an increased likelihood of hallux valgus. **Conclusions:** Tendinitis, plantar fasciitis, and osteoarthritis usually are secondary to overuse and increased stress on the soft tissues and joints, which may be directly related to increased weight on these structures.

Key Words: Ankle; Foot; Obesity

INTRODUCTION

Many physicians believe that obese individuals may suffer from an increased number of foot and ankle problems

from the additional mechanical stress of carrying excess weight.¹⁻²⁵ Data indicate that the prevalence of obesity in the United States is increasing in adults and children.²³ According to most recent data from the National Health and Nutrition Examination Survey, 66.5% of U.S. men and women 20 years and older are overweight and almost 32% are obese.²³ Overweight and obese individuals may suffer from problems such as plantar fasciitis, arthritis, bursitis, posterior tibial tendon dysfunction, and difficulty with shoe fit.^{1-3,4-22,24-31}

Gait changes also have been reported in obese individuals.^{25,26,28,29} During the gait cycle, obese individuals have been reported to take significantly shorter steps, walk slower, have increased step widths, and exhibit greater ankle dorsiflexion and less ankle plantarflexion throughout the gait cycle. Furthermore, they have increased Q angles, increased hip abduction angles, significantly more abducted foot angles, increased out-toeing, and a more flat-footed weight acceptance period in early stance. It is thought that some of these differences, such as the increased step width, slower stride and more abducted foot position may be secondary to an effort by the individual to increase stability.^{22,26,27} Many of the gait changes, such as a more abducted foot position, out-toeing, increased Q angle and increased step widths, also may be attributed to thick thighs.^{6,10,15,22} The obese person must rotate one thigh around the other to move forward.

Because of these reported differences in gait, some authors have attributed an increase in the incidence of overuse injuries to obesity.^{25,26,28-30}

In a study published in 1995,¹⁵ 580 females were evaluated for foot and ankle complaints based on their body weight. The definition of overweight was 20% or more above desirable weight and the definition of obesity was 30% above that level as outlined in the Metropolitan Life Insurance Tables.¹⁷ All patients were evaluated by an orthopaedic surgeon who noted any foot and ankle pathology. The diagnoses of plantar fasciitis, tendinitis, and osteoarthritis were associated with being overweight or obese.

The purpose of this paper was to report a survey of 1411 patients in an orthopaedic foot and ankle practice. The incidence of orthopaedic foot and ankle complaints

Corresponding Author:
Carol Frey, M.D.
Co-director, Fellowship
West Coast Sports Medicine Foundation
Orthopaedic Foot and Ankle
1200 Rosecrans, Suite 208
Manhattan Beach, California 90266
E-mail: Frey@wesportsmed.com

For information on prices and availability of reprints, call 410-494-4994 X226

was compared to body mass index (BMI), defined as the individual's body mass divided by the square of the height. This study was designed to compare people with a normal BMI to those with higher than normal BMI. Of note, the BMI has become controversial because many people, including physicians, use it as a medical diagnosis, which was not the purpose of the BMI. The BMI was meant to be used simply as a means of classifying individuals as having normal body composition or not. Lower than normal values indicate that a person is underweight and higher values indicate that a person is overweight. The BMI can be used to broadly categorize populations for statistical purposes, as was done in this study. With that in mind, underweight is considered to be less than 18.5, normal weight is equal to 18.5 to 24.9, overweight is equal to 25 to 29.9, and obese is a BMI of 30 or greater.^{4,7}

MATERIALS AND METHODS

One thousand four hundred and eleven adults were evaluated in this study, including 881 (62.4%) women and 530 (37.6%) men. All were patients in the office of an orthopaedic foot and ankle specialist (CF) and all were seen (active charts) during a selected 6-month period of time. The BMI was calculated for each individual using the standards of the World Health Organization. The BMI is defined as the individual's body mass divided by the square of the height. BMI can be calculated using the International System of Units (SI) (mass (kg) / height × height (m)) or Imperial Units $703 \times (\text{weight lb}/\text{height} \times \text{height in})$. BMI is commonly reported as a number without units.

Subjects were excluded from this study if they were under 18 years of age because the BMI is used differently for children. It is calculated the same way as for adults, but compared to typical values for other children in the same age group. Therefore, the same set thresholds are different in children than in adults. Occasionally, a patient did not want to have his or her weight or height measured or recorded.

Patients were diagnosed using information obtained during the physical examination by an orthopaedic foot and ankle specialist, with the aid of special tests (such as MRI) when indicated. Diagnoses were limited to those with an ICD-9 code. For example, tendinitis was used as one diagnostic category and included Achilles tendon, posterior tibial tendon, and peroneal tendon (ICD-9 code 726.90).

The subjects were divided into two groups: normal and overweight. The normal BMI's were considered to be 18.5 to 24.9 ($n = 684$; 48.1%) and the overweight/obese subjects had a BMI value of 25 or greater ($n = 738$; 51.9%). We had no patients who fell into the underweight category (BMI < 18.5).

A statistical analysis of the data was performed using SPSS v 12.0 (SPSS, Inc., Chicago, IL). A chi-squared analysis was performed comparing BMI two groups versus diagnosis. The chi square analysis was considered significant if $p < 0.0001$.

RESULTS

One hundred and twenty-three (65.4%, standard residual 2.6) of the overweight/obese subjects had a diagnosis of tendinitis compared to 65 (34.6%, standard residual 2.7) normal subjects. Fifty-eight (73.4%, standard residual 3.2) of the normal subjects had the diagnosis of hallux valgus compared to 21 (26.6%, standard residual -3.1) of the overweight/obese subjects. Twenty (80%, standard residual 2.3) of the normal subject had rheumatoid arthritis compared to five (20%, standard residual -2.2) of the overweight/obese subjects.

Logistic regression comparing BMI and hallux valgus demonstrated in our sample that 31.5% (0.315) probability that our sample population with hallux valgus will be overweight ($p < 0.0001$, 95% CI 0.89 to 0.525).

Logistic regression comparing BMI and tendinitis demonstrated that it was almost twice as likely (1.923, $p < 0.0001$, 95% CI 1.39 to 2.66) for an individual to have tendinitis of any tendon if overweight or obese.

The relationship of BMI and plantar fasciitis demonstrated a 1.4 times increased probability (1.400, $p < 0.040$, 95% CI 1.016 to 1.93) of plantar fasciitis being diagnosed in an overweight or obese patient.

In comparing BMI and rheumatoid arthritis there was only a 22.7% (.227) probability that a patient with rheumatoid arthritis was also overweight or obese ($p < 0.003$, 95%, CI 0.085 to 0.609).

Logistic regression comparing BMI and osteoarthritis of the foot or ankle demonstrated that it was 1.5 times more likely to have a diagnosis of osteoarthritis if patients were overweight or obese ($p < 0.058$, 95% CI 0.986 to 2.274)

General frequencies of diagnoses are noted in Tables 1 and 2.

DISCUSSION

The effects of being overweight have been well documented with respect to the cardiovascular system, kidney function, glandular function, arthritis, heart disorders, and longevity.^{1-6,8-16,18-31} Little has been reported, however, on the effects of being overweight on the foot and ankle. In our first study,¹⁵ we used height and weight tables to categorize patients into normal, overweight, and obese categories. The most common foot and ankle problems seen in

Table 1: Frequency of male and female

GENDER	Frequency	Percent
Male	530	37.6
Female	881	62.4
Total	1411	100.0

Table 2: Frequency of diagnoses

DIAGNOSIS	Frequency	Percent	Valid Percent	Cumulative Percent
Plantar fasciitis	189	13.3	13.4	13.4
Stress fracture/fracture	196	13.8	13.9	27.3
Degenerative/osteoarthritis	108	7.6	7.7	34.9
Tendinitis/tendinosis	208	14.6	14.7	49.7
Hallux valgus	85	6.0	6.0	55.7
Hallux rigidus	51	3.6	3.6	59.3
Hammer toes	48	3.4	3.4	62.7
Metatarsalgia	32	2.3	2.3	65.0
Metatarsophalangeal synovitis	57	4.0	4.0	69.0
Nerve Entrapment/Morton Neuroma/Neuropathy	129	9.1	9.1	78.2
Sprains	158	11.1	11.2	89.4
Other	125	8.8	8.9	98.2
Rheumatoid Arthritis	25	1.8	1.8	100.0
Total	1411	99.2	100.0	

the overweight and obese groups of patients were related to overuse problems such as plantar fasciitis, tendinitis, and osteoarthritis. Other problems seen more commonly in overweight and obese individuals were fractures and sprains.

In this study, we used BMI to categorize patients of normal body composition and those above normal (overweight or obese). Being overweight or obese significantly increased the chances of tendinitis in general. If the subjects were overweight or obese, there was an increased likelihood, although not significant, of plantar fasciitis and osteoarthritis. If the subjects were of normal BMI, there was an increased likelihood of hallux valgus.

The problems of tendinitis, plantar fasciitis, and osteoarthritis often are secondary to overuse and increased stress on the soft tissues and joints. This may be directly related to increased weight on these structures. Hallux valgus is thought to be related to ill-fitting shoes and is seen mostly in women¹⁵ and, therefore, is not related to weight.

REFERENCES

- Bellamy, N; Buchanan, WW; Goldsmith, CH; Campbell, J; Stitt, L: Validation study of WOMAC: A health status instrument for measuring clinically important patient-relevant outcomes following total hip or total knee arthroplasty for osteoarthritis. *J. Rheumatol.* **15**:1833–1840, 1988.
- Bostman, OM: Prevalence of obesity among patients admitted for elective orthopedic surgery. *Int. J. Obese Relat. Metab. Disord.* **18**:709–713, 1994.
- Cairney, J; Wade, TJ: Correlates of body weight in the 1994 National Population Health Survey. *Int. J. Obese Relat. Metab. Disord.* **22**:584–591, 1998.
- Calle, EE; Thun, MJ; et al.: Body mass index and mortality in a prospective cohort of US adults. *N. Engl. J. Med.* **341**:1097–1105, 1999.
- Cicuttini, FM; Baker, JR; Spector, TD: The association of obesity with osteoarthritis of the hand and knee in women: a twin study. *J. Rheumatol.* **23**:1221–1226, 1996.
- Cicuttini, FM; Spector, T; Baker, J: Risk factors for osteoarthritis in the tibiofemoral and patellofemoral joints of the knee. *J. Rheumatol.* **24**:1164–1167, 1997.
- Clinical Guidelines on the Identification, Evaluation, and Treatment of Overweight and Obesity in Adults, The evidence report. National Institute of Health. *Obes. Res.* **6 Suppl**:515–2095, 1998.
- Coggon, D; Reading, I; Croft, P; et al.: Knee osteoarthritis and obesity. *Int. J. Obese Relat. Metab. Disord.* **25**:622–627, 2001.
- Cooper, C; Inskip, H; Croft, P; et al.: Individual risk factors for hip osteoarthritis: obesity, hip injury, and physical activity. *Am. J. Epidemiol.* **147**:516–522, 1998.
- Davis, MA; Ettinger, WH; Neuhaus, JM; Cho, SA; Hauch, WW: The association of knee injury and obesity with unilateral and bilateral osteoarthritis of the knee. *Am. J. Epidemiol.* **130**:278–288, 1989.
- Epstein, AM; Read, JL; Hoefler, M: The relation of body weight to length of stay and charges for hospital services for patients undergoing elective surgery: A study of two procedures. *Am. J. Pub. Health* **77**:993–997, 1987.
- Felson, DT; Anderson, JJ; Naimark, A; Walker, AM; Meenan, RF: Obesity and knee osteoarthritis. The Framingham Study. *Ann. Intern. Med.* **109**:18–24, 1988.
- Felson, DT; Zhang, Y; Anthony, JM; et al.: Weight loss reduces the risk for symptomatic knee osteoarthritis in women: the Framingham Study. *Ann. Intern. Med.* **116**:535–539, 1992.
- Focht, BC; Ewing, V; Gauvin, L; Rejeski, WJ: The unique and transient impact of acute exercise on pain perception in older, overweight, or obese adults with knee osteoarthritis. *Ann. Behav. Med.* **24**:201–210, 2002.
- Frey, C; Chan, C; Carrasco, N: Obesity: Do weight gains lead to lower extremity pains? *BioMechanics.* **3**:30–34, 1996.
- Gelber, AC; Hochberg, MC; Mead, La; et al.: Body mass index in young men and the risk of subsequent knee and hip osteoarthritis. *Am J Med.* **107**:542–548, 1999.
- Harrison, GG: Height-weight tables. *Ann. Intern. Med.* **103**:489–494, 1985.

18. **Hart, DJ; Doyle, DV; Spector, TD:** Incidence and risk factors for radiographic knee osteoarthritis in middle-aged women: The Chingford Study. *Arthritis Rheum.* **42:**17–24, 1999.
19. **Hart, DJ; Spector, TD:** The relationship of obesity, fat distribution and osteoarthritis in women in the general population: The Chingford Study. *J. Rheumatol.* **20:**331–335, 1993.
20. **Lieverse, AM; Bierma-Zeinstra, SM; Verhagen, AP; et al.:** Influence of obesity on the development of osteoarthritis of the hip: a systematic review. *Rheumatology* **41:**1155–1162, 2002.
21. **Marks, R; Allegrante, JP:** Body mass indices in patients with disabling hip osteoarthritis. *Arthritis Res.* **4:**112–116, 2002.
22. **Messier, SP; et al.:** Exercise and weight loss in obese older adults with knee osteoarthritis: a preliminary study. *J. Am. Geriatr. Soc.* **48:**1062–1072, 2000.
23. National Health & Nutrition Examination Survey (NHANES), Office of Information Services, National Center for Health Statistician, Center for Disease Control & Prevention, www.cdc.gov/nchs/nhanes.htm.
24. **Oliveria, SA; Felson, DT; Cirillo, P; et al.:** Body weight, body mass index, and incident symptomatic osteoarthritis of the hand, hip, and knee. *Epidemiology* **10:**161–166, 1999.
25. **Petrella, RJ; Bartha, C:** Home based exercise therapy for older patients with knee osteoarthritis: a randomized clinical trial. *J Rheumatol.* **27:**2215–2221, 2000.
26. **Sharma, L; Lou, C; Cahue, S; Dunlop, DD:** The mechanism of the effect of obesity in knee osteoarthritis: the mediating role of malalignment. *Arthritis Rheum.* **43:**568–575, 2000.
27. **Sturmer, T; Gunther, KP; Brenner, H:** Obesity, overweight and patterns of osteoarthritis: the Ulm Osteoarthritis Study. *J. Clin. Epidemiol.* **53:**307–313, 2000.
28. **Toda, Y; Segal, N; Kato, A; et al.:** Correlation between body composition and efficacy of lateral wedged insoles for medial compartment osteoarthritis of the knee. *J. Rheumatol.* **29:**541–545, 2002.
29. **Toda, Y:** The effect of energy restriction, walking, and exercise on lower extremity lean body mass in obese women with osteoarthritis of the knee. *J. Orthop. Sci.* **6:**148–154, 2001.
30. **Toda, Y; Toda, T; Takemura, S; et al.:** Change in body fat, but not body weight or metabolic correlates of obesity, is related to symptomatic relief of obese patients with knee osteoarthritis after a weight control program. *J. Rheumatol.* **25:**2181–2186, 1998.
31. **Verbrugge, LM; Gates, DM; Ike, RW:** Risk factors for disability among U.S. adults with arthritis. *J. Clin. Epidemiol.* **44:**167–182, 1991.