

1 **Severity of Foot Pain is linked to the Prevalence of Depressive Symptoms**

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1 **Abstract**

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3 **Objective:** Associations between pain and depression are well known, yet foot pain, common in
4 populations, has been under-studied. This cross-sectional study examined foot pain and severity
5 of foot pain with depressive symptoms in adults.

6 **Methods:** Framingham Foot Study (2002-08) participants completed questionnaires including
7 foot pain (no/yes; none, mild, moderate or severe pain) and Center for Epidemiologic Studies
8 Depression Scale (CES-D ≥ 16 indicated depressive symptoms). Age and body mass index
9 (BMI) were also assessed. Sex-specific logistic regression was used to calculate odds ratios
10 (OR) and confidence intervals for associations of foot pain with depressive symptoms adjusting
11 for age and BMI. In a subset, further models adjusted for leg pain, back pain, or other joint pain.

12 **Results:** Of 1464 men and 1857 women, mean age was 66 ± 10 years. In men and women, 21%
13 and 27% reported depressive symptoms, respectively. Compared to those with no foot pain and
14 independent of age and BMI, both men and women with moderate foot pain had ~2-fold
15 increased odds of depressive symptoms; men with severe foot pain had OR=4 (95% CI 2.26 –
16 8.48), while women with severe foot pain had OR=3 (95% CI 2.02 – 4.68). Considering other
17 pain regions attenuated ORs but the pattern of results remained unchanged.

18 **Conclusion:** Even after adjusting for age, BMI and other regions of pain, those reporting worse
19 foot pain were more likely to report depressive symptoms. These findings suggest that foot pain
20 may be a part of a broader spectrum with impact beyond localized pain and discomfort.

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1 **Significance and Innovations**

- 2 • Foot pain and depressive symptoms are common in older adults and yet not often
3 considered together; Further, the severity of foot pain has been seldom considered.
- 4 • Severity of foot pain was significantly associated with the prevalence of depressive
5 symptoms.
- 6 • The association between severity of foot pain and depressive symptoms remained after
7 controlling for the effect of pain in other regions.

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1 **Introduction**

2 Foot pain is a common symptom in the general population and is estimated to affect 24% of
3 adults aged 45 years and over¹. Depressive symptoms are also commonly reported in older
4 adults, with clinically relevant depression affecting approximately 14% of community-dwelling
5 people aged 55 years and over² and approximately 15% of older US Medicare beneficiaries
6 reporting the use of anti-depressant medication³. Although several epidemiologic studies have
7 shown associations between bodily pain and depressive symptoms⁴, the specific relation between
8 foot pain and depression has received relatively less attention in the literature. Further, the
9 severity of foot pain has been rarely considered in studies.

10

11 Previous findings suggest a possible relation between foot pain and depressive symptoms.
12 Several cross-sectional studies have shown that individuals with foot pain are more likely to
13 report depression^{5,6} and exhibit lower scores on health-related quality of life questionnaires⁷⁻¹⁰.
14 One recent prospective study reported that low scores on the mental health component of the
15 Short Form-36 (SF-36) predicted worsening of foot pain over three years¹¹. However, the
16 relation between severity of foot pain and depression has received less attention. A study
17 evaluating the Manchester Foot Pain and Disability Index (MFPDI) reported a significant
18 association between the MFPDI total score and the geriatric depression scale in 301 older
19 adults¹², and more recently, a study of 84 women with heel pain showed the Depression, Anxiety
20 and Stress Scale to be associated with the degree of foot pain and impaired foot function¹³.

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22 The available literature is limited by small samples drawn from specific clinical populations
23 and limited adjustment for confounders in statistical models. In particular, no studies have

1 adjusted for the confounding effect of pain at other regions. These factors along with the paucity
2 of information on foot pain severity provide the rationale for our investigation. Therefore, the
3 purpose of this cross-sectional study was to examine the independent association of foot pain and
4 severity of foot pain with depressive symptoms in a large population-based study of community-
5 dwelling older adults from the Framingham Foot Study, adjusting for important potential
6 confounders.

7 **Methods:**

8 *Participants*

9
10 Participants were from the Framingham Foot Study^{14, 15}, a cohort derived from the members
11 of the Framingham Original Cohort, the Framingham Offspring Cohort and a community
12 sample, as described previously. In 1948, the Framingham Original Cohort was formed from a
13 two-thirds sample of town population to investigate risk factors for heart disease. The
14 Framingham Offspring Cohort was added in 1972 to study familial risk factors of heart disease.
15 Members of the Framingham Study Cohorts are examined every 2-4 years. In 2002-08,
16 Framingham Study cohort members and another population-based sample were invited to take
17 part in the Framingham Foot Study, an ancillary study of the Framingham Heart Study. The only
18 inclusion criterion was to be cognitively intact as indicated by the Mini Mental Status Exam¹⁶, in
19 order to be able to accurately answer pain and depression questions.

20
21 Between 2002 and 2008, participants from the Framingham Foot Study cohort were seen by
22 a trained clinical examiner to obtain a standardized, validated foot assessment. The 20-item
23 Center for Epidemiologic Studies Depression Scale (CES-D) questionnaire was also

1 administered. Other data collected included height, weight and age at time of examination.
2 Participants who had complete information on foot pain, CES-D score, and covariates were
3 included in this analysis. The Framingham Foot Study was approved by the Hebrew SeniorLife
4 institutional review board, and participants provided informed consent prior to enrollment.

5

6 *Assessment of Foot Pain*

7 Foot pain was determined using the response to the question: “On most days, do you have
8 pain, aching, or stiffness in either of your feet¹⁴?” Responses were collapsed into two groups:
9 yes, pain in one or both feet; or no pain in either foot. If the participant reported foot pain in
10 either foot, they were then asked to categorize the severity of that foot pain with possible
11 responses of no pain, mild pain, moderate pain or severe pain. In the case where foot pain was
12 reported in both feet, the foot that was reported as having the most severe pain was used in the
13 analysis.

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15 *Prevalence of Depressive Symptoms*

16 The Center for Epidemiologic Studies Depression scale (CES-D) was used to assess
17 depressive symptoms¹⁷. The CES-D is a self-reported measure, which has previously been
18 validated. The CES-D is a 20-item questionnaire that asks participants to rate their feelings over
19 the past week. Each response ranges from a score of 0 to 3 (0 = rarely or none of the time, 1 =
20 some or little of the time, 2 = moderately or much of the time, 3 = most or almost all the time).
21 The scores from individual responses were summed. Possible scores range from 0 to 60, where
22 higher scores indicate more severe depressive symptoms. For this analysis, participants with

1 CES-D score ≥ 16 were considered to have depressive symptoms present¹⁸. Continuous measures
2 of CES-D were also examined.

3

4 *Leg pain, back pain and other joint pain*

5 Reporting of pain at other anatomical regions was determined using a homunculus with
6 major joints indicated. Each participant was asked to indicate the location of any joints with pain,
7 aching or stiffness on most days. For our analyses, responses were categorized into three pain
8 groups: leg pain, back pain and other joint pain. If the participant marked joint pain in any joint
9 at the hips, knees or ankles, they were categorized as having leg pain. If the participant marked
10 joint pain at either the lower back, mid back or upper back, they were categorized as having back
11 pain. If the participant marked joint pain in the neck, shoulder, elbow or wrist, they were
12 categorized as having other joint pain. Pain at other joint sites was not queried in the
13 community-based sample of the Framingham Foot Study and is missing for these participants.

14

15 *Covariates*

16 Covariates considered in our analyses were age, height, weight, BMI, smoking status and
17 physical activity. Age in years was recorded at the time of examination. Weight was measured
18 using a standardized balance beam scale and rounded to the nearest half pound. Height was
19 measured using a calibrated stadiometer and rounded to the nearest quarter inch. Body mass
20 index (kg/m^2) was calculated using the weight and height measures. Smoking status was reported
21 as whether a participant smoked cigarettes in the past year (y/n). Physical activity was estimated
22 using the validated physical activity scale for the elderly (PASE) score¹⁹.

23

1 *Statistical Analysis*

2 All analyses were performed sex-specific. Descriptive statistics or frequencies where
3 appropriate, were generated separately for men and women. Sex-specific logistic regression
4 models were used to calculate odds ratios (OR) and 95% confidence intervals (CI) for the
5 association between foot pain (y/n or severity of foot pain) with depressive symptoms (y/n)
6 adjusting for age and BMI. In a subset of participants, logistic regression models were further
7 adjusted for leg pain (hip, knee, ankle), back pain and other joint pain (neck, shoulder, elbow,
8 wrist). Continuous measures of CES-D data were examined using linear regression modeling
9 with a 2-sided p-value of < 0.05 denoting statistical significance. All statistical analyses were
10 conducted using SAS statistical analysis package, version 9.3 (SAS Institute, Cary, NC).

11

12 **Results**

13 Of the 3429 participants in the Framingham Foot Study, 3321 participants (1464 men and
14 1857 women) had complete data on foot pain and CES-D scores (Supplemental Figure1). The
15 mean age of the participants was 66 years (range of 36-100 years). Mean BMI in men was 29
16 kg/m² (SD = 4.7) and mean BMI in women was 28 kg/m² (SD = 6.0). 56% of the participants
17 were female (Table1). Depressive symptoms (CES-D score \geq 16) were reported by 21% of men
18 and 27% of women. Pain, aching, or stiffness in either foot on most days was reported by 19% of
19 the men and 29% of the women. Among the men, 8% indicated mild foot pain, 9% indicated
20 moderate foot pain while 3% reported severe foot pain. Among the women, 11% indicated mild
21 foot pain, 13% indicated moderate foot pain while 6% reported severe foot pain.

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1 Unadjusted models show that men with foot pain had 79% increased odds of reporting
2 depressive symptoms compared to those participants without foot pain, while women with foot
3 pain had 84% increased odds compared to women without foot pain (see Table 2). There were
4 also increasing odds of reporting depressive symptoms as pain severity increased for both men
5 and women.

6
7 After adjusting for age and BMI, foot pain remained significantly associated with depressive
8 symptoms in men (OR = 1.84, 95% CI 1.36 – 2.48) and women (OR = 1.93, 95% CI 1.55 –
9 2.45). Table 2 also shows adjusted OR and 95% CI for associations between severity of foot pain
10 and depressive symptoms for men and women. Men with moderate foot pain compared to men
11 with none (referent) had 2-fold increased odds of reporting depressive symptoms; men with
12 severe foot pain had 4-fold increased odds, independent of age and BMI. Women showed a
13 similar trend for moderate foot pain while women with severe foot pain had 3-fold odds
14 compared to women without foot pain, independent of age and BMI. For both men and women,
15 mild foot pain showed increased odds (ORs of = 1.3 and 1.4 respectively), but was only
16 statistically significant for women ($p = .046$). Adding smoking status and physical activity did
17 not change the estimates of effect and these variables were dropped from the models.

18
19 In a subset of 2138 participants (944 men and 1194 women) we had data on leg pain, back
20 pain, and other regions of joint pain, in addition to the data on foot pain and CES-D scores. As
21 many participants were missing these data on other locations of pain, analyses as seen in Table 2
22 were repeated for the subset (see Table 3). The age and BMI adjusted models that also
23 considered other regions of pain showed a similar pattern of higher odds of depression with

1 increases in foot pain severity (not statistically significant for mild foot pain). In men, the added
2 location of pain variables (leg pain OR=1.18, p=0.338; back pain OR=1.33, p=0.102; other pain
3 OR=1.26, p=0.169) were non-significant, while in women, back pain (OR=1.49, p=0.007), other
4 pain (OR= 1.41, p=0.019) but not leg pain (OR=0.96, p=0.775) were significantly associated
5 with depressive symptoms.

6 Models that considered CES-D as a continuous variable also showed significant associations
7 between foot pain and depressive symptoms for men (p = <.0001) and for women (p = <.0001)
8 adjusted for age and BMI. Men with mild foot pain showed non-significant results, however men
9 with moderate and severe pain were significantly more likely to report depressive symptoms (p =
10 <.0001 for both) adjusting for age and BMI. Women with mild foot pain (p = 0.0017), moderate
11 pain (p = <.0001) and severe pain (p = <.0001) were also more likely to report depressive
12 symptoms. Even after considering leg, back and other sites of pain, the relation between severity
13 of foot pain and CES-D remained similar.

14

15 **Discussion**

16 This cross-sectional study reports the associations between foot pain and depressive
17 symptoms, both unadjusted and controlling for the effects of age and BMI in a population-based
18 study of community- dwelling older adults. Foot pain was common (19% of men and 29% of
19 women) and similar proportions of men (21%) and women (27%) reported depressive symptoms,
20 defined using the commonly-used CES-D cut-point score of ≥ 16 ¹⁸. Our unadjusted findings are
21 consistent with previous studies reporting associations between foot pain and a range of
22 measures of mental health, including depression, anxiety and the SF-36 mental health component
23 score^{5-10, 12, 13}. Importantly, we also found evidence of a dose-response relationship between

1 increasing severity of foot pain and depressive symptoms. The pattern of increased severity of
2 foot pain with increased depressive symptom score remained significant even after adjusting for
3 age and BMI, as well as further adjustment for the presence of joint pain in other anatomic
4 regions. These results may be important and clinically relevant as they suggest that foot pain may
5 be a part of a broader spectrum with an impact upon a person beyond localized pain in one
6 bodily region.

7
8 Our research employed a cross-sectional study design. Although it is not possible to infer
9 temporal relationships, it is likely that the association between foot pain and depressive
10 symptoms is bidirectional, i.e. foot pain may lead to depression but depression may also lead to
11 foot pain. We were unable to examine this further. However, Butterworth et al¹¹ examined the
12 latter and found that participants who had a higher SF-36 mental component summary
13 (indicative of better mental health) at baseline demonstrated slower progression of foot pain in a
14 three year follow up. Several other factors are likely to mediate this relationship. For example,
15 Iliffe et al²⁰ found that although older people with pain were more likely to report depression,
16 social networks and functional status were more strongly associated with depression than pain
17 severity.

18
19 Bodily pain most often affects several regions simultaneously²¹, so our observation of an
20 independent association between foot pain and depressive symptoms after adjusting for pain
21 elsewhere suggest that factors other than pain may be partly responsible for this association. For
22 example, Iliffe et al²⁰ found that although older people with pain were more likely to report
23 depression, difficulty performing activities of daily living was more strongly associated with

1 depression than pain severity. Several studies have shown that foot pain impairs activities of
2 daily living in older people^{22,23}, so it is likely that the impact of foot pain on mobility is a key
3 mediator of the association with depressive symptoms. While physical activity in our study did
4 not contribute to the effect estimates, it may well be that assessments of function are important.
5 The lack of information on function is a potential limitation.

6
7 The strengths of the current study are that the sample is derived from a large population-
8 based, well-characterized cohort that includes large numbers of both men and women. Our study
9 controlled for the well known effects of age and BMI on pain, and we were also able to take into
10 account the effect of possible joint pain experienced at other regions (leg, back and other) in
11 consideration of foot pain and depressive symptoms. Nevertheless, the findings were limited by
12 the cross-sectional study design from which one cannot determine temporality. We cannot infer
13 causality, or comment on whether foot pain preceded depression. In addition, the Framingham
14 Study is primarily comprised of Caucasians, thus limiting generalizability to non-Caucasian
15 groups. Also, although we adjusted for several potential confounders, there is likely to be some
16 degree of residual confounding. Finally, severity of foot pain was reported in categories, and thus
17 misclassification may have occurred although participants self-selected their foot pain group as
18 none, mild, moderate or severe. It is likely that the mild group contains persons with differing
19 levels (including none) of severity. However, the consistently increasing ORs across the pain
20 severity categories may indicate that the ‘signal’ was able to rise above any ‘noise’ from random
21 misclassification.

22 23 **Conclusion**

1 Both presence of foot pain as well as severity of foot pain were significantly associated with
2 the reporting of depressive symptoms in our study. Participants reporting worse foot pain were
3 more likely to also report depressive symptoms, independent of age and BMI. Furthermore,
4 considering joint pain at other regions (leg, back and other) slightly attenuated the results but the
5 pattern with increased severity of foot pain remained consistent with showing higher odds of foot
6 pain and depressive symptoms. These findings suggest that foot pain may be a part of a broader
7 spectrum with an impact beyond localized pain and discomfort.

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18 Drafting manuscript: AA, ABD, PK HBM, and MTH. Revising manuscript content: AA, ABD,
19 PK, HBM, and MTH. Approving final version of manuscript: AA, ABD, PK, HBM, and MTH.
20 All authors take responsibility for the integrity of the data analysis.

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1 Table 1: Characteristics of Men and Women in the Framingham Foot Study (2002-08) with
 2 Information from Foot Examination and CES-D Scores

Characteristic*	Men (<i>n</i> = 1464)	Women (<i>n</i> = 1857)
Age, years	66.5 ± 10.2	66.5 ± 10.9
Weight, pounds	193.9 ± 34.6	158.4 ± 35.8
Height, inches	68.6 ± 2.8	63.1 ± 2.6
Body mass index, kg/m ²	28.9 ± 4.7	28.0 ± 6.0
Center for Epidemiologic Studies Depression Scale	8.6 ± 8.9	10.3 ± 9.5
Foot pain, <i>n</i> (%)		
No pain	1187 (81.1)	1314 (70.8)
Pain	277 (18.9)	543 (29.2)
Severity, <i>n</i> (%)		
No foot pain	1187 (81.1)	1314 (70.8)
Mild foot pain	114 (7.8)	208 (11.2)
Moderate foot pain	126 (8.6)	233 (12.6)
Severe foot pain	37 (2.5)	102 (5.5)
Depressive symptoms, <i>n</i> (%)		
No (CES-D score < 16)	1164 (79.5)	1364 (73.5)
Yes (CES-D score ≥ 16)	300 (20.5)	493 (26.6)

3 * Mean ± SD unless indicated as *n* (%)

1 Table 2: Odds ratios (ORs) and 95% confidence intervals (95% CIs) for the association between
 2 severity of foot pain and depressive symptoms in the men and women of the Framingham Foot
 3 Study (2002-08)*

	n (%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)**
Men			
Foot pain (y/n)	277 (19)	1.79 (1.33, 2.41)	1.84 (1.36, 2.48)
Severity			
No foot pain (referent)	1187 (81)	1.0	1.0
Mild foot pain	114 (8)	1.24 (0.77, 1.97)	1.26 (0.79, 2.02)
Moderate foot pain	126 (9)	1.83 (1.21, 2.76)	1.88 (1.25, 2.86)
Severe foot pain	37 (2)	4.164 (2.15, 8.07)	4.34 (2.26, 8.48)
Women			
Foot pain (y/n)	543 (29)	2.01 (1.62, 2.50)	1.93 (1.55, 2.45)
Severity			
No foot pain (referent)	1314 (71)	1.0	1.0
Mild foot pain	208 (11)	1.51 (1.09, 2.08)	1.40 (1.01, 1.94)
Moderate foot pain	233 (13)	2.11 (1.57, 2.83)	2.09 (1.55, 2.82)
Severe foot pain	102 (5)	3.08 (2.05, 4.65)	3.08 (2.02, 4.68)

4 *Depressive symptoms dichotomized as CES-D score ≥ 16 or <16

5 **Adjusted for age and BMI

6

1 Table 3: Further Adjustment For Other Sites Of Joint Pain in the Association Between Severity
 2 of Foot Pain and Depressive Symptoms in Men And Women, Odds ratios (ORs) and 95%
 3 confidence intervals (95% CIs), the Framingham Foot Study (2002-08)*

	n (%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)**
Men			
Foot pain (y/n)	198 (21)	1.77 (1.27, 2.47)	1.56 (1.09, 2.23)
Severity			
No foot pain (referent)	746 (79)	1.0	1.0
Mild foot pain	87 (9)	1.03 (0.62, 1.71)	0.91 (0.54, 1.55)
Moderate foot pain	81 (9)	2.19 (1.37, 3.52)	1.87 (1.14, 3.06)
Severe foot pain	30 (3)	3.97 (1.89, 8.32)	3.64 (1.71, 7.75)
Women			
Foot pain (y/n)	370 (31)	1.90 (1.48, 2.45)	1.54 (1.17, 2.02)
Severity			
No foot pain (referent)	824 (69)	1.0	1.0
Mild foot pain	141 (12)	1.31 (0.90, 1.90)	1.08 (0.73, 1.59)
Moderate foot pain	152 (13)	2.02 (1.42, 2.88)	1.69 (1.16, 2.45)
Severe foot pain	77 (6)	3.25 (2.01, 5.23)	2.53 (1.54, 4.15)

4 *Depressive symptoms dichotomized as CES-D score ≥ 16 or <16

5 **Adjusted for age, BMI, leg pain, back pain and other joint pain in a subset of 2138 participants
 6 (944 men and 1194 women)

7