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Determinants of Self-Reported Health Status in a Population-Based Sample of Persons with Radiographic Knee Osteoarthritis

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Abstract

Objective—Knee osteoarthritis (OA) is highly prevalent and disabling. Patients with radiographic knee OA may experience pain and functional impairment, which can diminish their health status. Our objective was to determine factors associated with self-reported health status in a national population-based sample with radiographic knee OA.

Methods—Our sample included all NHANES III participants who underwent a knee radiograph and were found to have radiographic OA (defined as Kellgren-Lawrence (K-L) grade two or higher). Self-reported health status was determined by asking the participant to rate their overall health as excellent, very good, good, fair, or poor. Self-reported health status was analyzed as an ordinal variable using cumulative logit regression, a dichotomous variable (excellent/very good/good vs. fair/poor) using logistic regression, and as a continuous variable after transformation using linear regression.

Results—Forty-two percent (N=1,021) of NHANES III participants with a knee radiograph were included in this analysis. The multivariable analyses were performed on 1,009 (99%) of the eligible participants with complete data. We found that non-white race, lower income, more comorbidities, and greater functional limitation were associated with worse self-reported health status in all three multivariable analyses.

Conclusions—To the best of our knowledge, this is the first study that quantifies the role of clinical, radiographic and socio-economic factors associated with self-reported health status in a population-based sample of patients with knee OA. Self-reported health status in patients with knee OA is associated with functional status and comorbidity.

Keywords

knee osteoarthritis; health status; NHANES

Introduction

Knee osteoarthritis (OA) is painful, disabling, and costly, and diminishes a person's health status dramatically. Over 10 million people in the United States have knee OA.¹ OA of the knee is one of the five leading causes of disability among the elderly.²

Health status is a multi-dimensional domain comprising biological, physical, and emotional functioning.³ Self-reported health status is a measure of how one perceives and reports one's own well-being. For example, participants may rate their health as excellent, very good, good, fair, or poor. This sort of self-reported information provides an important indicator of a person's health status.⁴ A variety of methods have been proposed to express self-reported health status.⁵ One method is to classify the responses into two groups (excellent, very good, or good vs. fair or poor).⁵ Another method is to analyze the responses as an ordinal variable.⁵ Lastly, a particularly transparent approach is to express self-reported health status on a scale from 0 to 1, where 0 corresponds to worst possible health and 1 corresponds to perfect health. Such scales are easy to interpret, and the unitless 0 to 1 response scale permits comparisons across medical conditions.³

Many studies have documented the effect of knee OA - as well as other specific conditions - on the self-reported health status of patients' lives.⁶ Few studies, however, have attempted to characterize or explain variability in self-reported health status within specific conditions. For example, the Beaver Dam Health Outcomes Study examined the influence of dozens of conditions on self-reported health status, but only controlled for age. It did not examine the contribution of comorbidities, the severity of symptoms of the disease, or other patient characteristics on self-reported health status.⁶ Another study conducted among subjects enrolled in Pennsylvania's Pharmaceutical Assistance Contract for the Elderly (PACE) examined the effect on self-reported health status of OA and rheumatoid arthritis compared to no arthritis. This study controlled for important factors, including age, gender, race, income and comorbidities. However, the diagnosis was not specific to knees and radiographs were not used to determine the presence of OA.⁷

Our objective was to determine the factors associated with self-reported health status in a national population-based sample of persons affected by radiographic knee OA. We chose participants affected by radiographic knee OA so that we could examine the impact of symptomatic OA on a person's self-reported health status. We used data from the Third National Health and Nutrition Examination Survey (NHANES III), which is the most recent NHANES to perform radiographs of the knee, to identify factors that correlate with self-reported health status in individuals in a population-based sample with radiographic knee OA.

Methods

Sample

NHANES III is a national population-based survey that was conducted from 1988-1994 by the National Center for Health Statistics of the Center for Disease Control and Prevention. The survey was conducted in two phases. Phase I took place from 1988-1991 and Phase II from 1991-1994. NHANES III survey data were collected during a household interview. All participants were then asked to schedule an appointment at a medical examination center where additional data would be collected. Additional details about patient recruitment and selection for the NHANES III survey has been documented.⁸

Radiographic assessment

The knee radiographs were performed using a non-weight bearing anteroposterior approach according to NHANES III protocol.⁹ Radiographs were performed on both knees of all participants surveyed between 1991 and 1994 who were 60 years of age or older and could transfer themselves to the x-ray table under their own power. Severity of radiographic knee OA was defined by Kellgren-Lawrence (K-L) grade, where zero indicates no knee OA, one indicates a questionable osteophyte (doubtful knee OA), two indicates a definite osteophyte but no joint space narrowing (mild knee OA), three indicates moderate narrowing of the joint space (moderate knee OA), and four indicates severe narrowing of the joint space (severe knee OA).¹⁰ K-L grades were computed for each knee by a trained radiologist. For our analysis we used the greater of the right and left K-L grades, and we defined radiographic knee OA as having a K-L grade of at least two. This definition served as the inclusion criterion for this analysis.

Outcome: Self-reported health status

Self-reported health status was determined by asking the participant to rate their overall health as excellent, very good, good, fair, or poor. Self-reported health status was analyzed using three techniques. First, self-reported health status was dichotomized as excellent, very good, or good *versus* fair or poor. Next, we considered self-reported health as an ordinal variable. Lastly, we assigned each possible response a rating. To address the issue of transforming ordinal variables to a rating scale using equal length intervals, we used the rating scale proposed by Diehr and colleagues.¹¹ Values of 0.95, 0.90, 0.80, 0.30, and 0.15 were assigned to the five possible responses respectively.¹¹ The rating scale was then transformed to an estimate of Standard Gamble utilities (0-1; worst to best possible health) using the power transformation suggested by Torrance and colleagues to create a continuous self-reported health status score, which is often called a utility score in economic evaluations.¹²

Correlates of self-reported health status

Sociodemographic characteristics—Sociodemographic factors, such as age, gender, race/ethnicity, and income were hypothesized to be associated with self-reported health status. Age was classified into five categories; 1) 60-64 years old, 2) 65-69 years old, 3) 70-74 years old, 4) 75-79 years old, and 5) 80+ years old. Race/ethnicity was classified into three categories; 1) Hispanic, 2) Non-Hispanic Black, and 3) Non-Hispanic White. Income was also classified into four categories; 1) Less than \$20,000, 2) \$20,000-\$34,999, 3) \$35,000 or more, and 4) missing. The missing category was added so that participants who did not report their income could be included in the multivariable regression models.

Comorbidities—NHANES III asks their participants several closed-ended questions about the presence of medical problems at the time of the survey or in the past. A comorbidity index was computed by counting the total number of self-reported medical problems. These included asthma, chronic bronchitis, emphysema, congestive heart failure, myocardial infarction, stroke, elevated cholesterol, hypertension, diabetes, cancer (including skin cancer), fractures of the hip, wrist, or spine, gout, lupus, osteoporosis, back pain most days for at least one month, goiter, urinary tract infection, pneumonia in the last 12 months, blindness, cataracts, and thyroid disease. We then categorized the total number of comorbidities into three levels; 0-1 comorbidities, 2-3 comorbidities, and 4 or more comorbidities. Obesity status was considered as a separate factor and was defined as 1) non-obese (BMI < 30), 2) obese (BMI ≥ 30) and 3) missing.¹³ The missing category for obesity status was added so that participants with missing BMI values could be included in the multivariable regression model.

Radiographic Severity, Knee Pain, and Functional Limitation—Severity of radiographic knee OA was classified using K-L grade: we analyzed K-L grade as a categorical variable (grades II, III, and IV). Knee pain was defined as having knee pain on most days for at least six weeks. A composite functional limitation index was defined from two questions in the household interview; 1) difficulty walking a quarter-mile and 2) difficulty stooping, crouching, or kneeling. The participants were assumed to have reported zero limitations if they answered “No” to both questions, one limitation if they answered “Yes” to one of the questions and two limitations if they answered “Yes” to both questions. We performed internal validation of the index by examining its association with radiographic severity and use of a walking aid, such as a cane or walker.

Statistical analysis

The interview and examination datasets were merged to produce a single data set that contained all relevant information. Three analyses were performed; one for each of the three techniques of examining the outcome of self-reported health status.

Self-reported health status as a dichotomous variable—Multivariable logistic regression was performed on our dichotomous outcome to obtain odds ratios of being in fair or poor health.

Self-reported health status as an ordinal variable—Multivariable cumulative logit regression was performed on our ordinal outcome to obtain cumulative odds ratios. Cumulative odds ratios that were greater than one were more indicative of worse self-reported health status.

Self-reported health status as a continuous variable—We used two-sample independent t-tests and one-factor analysis of variance to compare unadjusted mean estimates of our self-reported health status score for our hypothesized correlates. We employed multivariable linear regression to obtain adjusted mean estimates of the self-reported health status score. Scheffe's procedure was used to adjust for multiple comparisons where appropriate.¹⁴

We tested for interactions to identify specific subgroups that report a worse self-reported health status for all three variants of the outcome. The interaction between radiographic severity and knee pain was of particular interest, but we also examined interactions involving functional limitation with comorbidity, comorbidity with obesity, and gender with radiographic severity, comorbidity, and obesity. P-values less than 0.05 were considered to be statistically significant. All statistical analyses were performed using version 9.1 of SAS statistical software (Cary, NC).

We employed survey regression methods as a sensitivity analysis to take into account the survey design. We did not use the sampling weights in this analysis because the variables used to determine the weights (age, gender, and race/ethnicity) were also predictors of interest.¹⁵ The methods used in our data analyses were consistent with a more detailed discussion of the use of sampling weights for NHANES analyses.¹⁵ 16 The results that took into account the possible correlations between individuals within primary sampling units and strata were analogous to the standard multiple linear regression and are not presented here because the results would be redundant.

Results

Study sample

Two thousand five hundred eighty-six participants completed the NHANES III household questionnaire and had the physical examination. Of the 2,586 participants, 2412 (93%) had a K-L score evaluated on at least one knee. Of these, 1,021 (42%) had radiographic knee OA (K-L II or higher), which comprised the sample for this analysis.

The baseline demographic features of the sample are presented in Table 1. The average age was 73 and the sample primarily consisted of females (61%). A substantial portion of the sample consisted of racial/ethnic minorities (46%) and 55% of the participants reported annual incomes of less than \$20,000. Seventy-six percent had at least two comorbid conditions, and 25% were obese. Seventy-one percent had a K-L grade of II and 63% reported at least one functional limitation.

Internal validation of the functional limitation index

The functional limitation index was highly correlated with radiographic severity and the self-reported use of a walking aid. Seventeen percent of participants who reported no functional limitations had a K-L grade of IV, while 51% of participants who reported two functional limitations had a K-L grade of IV. Also, 6% of participants who reported zero functional limitations used a walking aid compared to 74% who reported two functional limitations (Figure 1).

Correlates of self-reported health status: Dichotomous outcome

Results of the multivariable logistic regression are shown in Table 2. We found that clinical (functional limitation and comorbidity) and socio-economic (race/ethnicity and income) factors were associated with self-reported health status, but not radiographic. Those with one functional limitation (OR=1.68; 95% CI: 1.13, 2.48) or two functional limitations (OR=4.42; 95% CI: 2.95, 6.64) were more likely to be in fair or poor health than those with zero functional limitation. Those with two or three comorbidities (OR=2.68; 95% CI: 1.76, 4.10) or four or more comorbidities (OR=5.49; 95% CI: 3.48, 8.66) were more likely to be in fair or poor health than those reporting zero or one comorbidities. Non-Hispanic Blacks (OR=2.32; 95% CI: 1.56, 3.43) and Hispanics (OR=2.94; 95% CI: 1.97, 4.39) were more likely to be in fair or poor health than Non-Hispanic Whites. Those making over \$35,000 (OR=0.44; 95% CI: 0.27, 0.72) were less likely to be in fair or poor health than those making less than \$20,000. We did not find a statistically significant association between age, gender, obesity status, K-L grade, or knee pain status with self-reported health status in this model.

Correlates of self-reported health status: Ordinal outcome

Results of the multivariable cumulative logit regression yielded similar results as the multivariable logistic regression and are also presented in Table 2. Functional limitation, comorbidity, race/ethnicity, and income remained associated with self-reported health status. The multivariable cumulative logit regression model also showed that age and gender were associated with self-reported health status. NHANES III participants that were 80 years old or older (cumulative OR = 0.63; 95% CI: 0.42, 0.93) were less likely to have a lower self-reported health status than those who were between the ages of 60 and 64. Also, males (cumulative OR = 1.32; 95% CI: 1.03, 1.68) were more likely to have a lower self-reported health status than females.

Correlates of self-reported health status: Continuous health status score

The mean self-reported health status score for the entire sample was 0.81 with a standard deviation of 0.24. Unadjusted and adjusted mean self-reported health status scores are shown in Table 3. K-L grade and knee pain both had a substantial influence on self-reported health status scores in the unadjusted analysis ($p=0.01$ and $p<0.01$ respectively). However, these two variables were not associated with self-reported health status scores in the multivariable regression ($p=0.21$ and $p=0.71$ respectively). Those with increased functional limitation experienced significantly lower self-reported health status scores ($p<0.01$ for unadjusted and adjusted analyses; see Table 3). In the adjusted analysis, those reporting zero functional limitations had a mean self-reported health status score of 0.85 (95% CI: 0.82, 0.89), while those reporting two functional limitations had a mean self-reported health status score of 0.70 (95% CI: 0.67, 0.73).

Comorbidities greatly influenced self-reported health status scores in this sample. Figure 2 displays the relationship between comorbidities and the self-reported health status score stratified by functional limitation. While the interaction between comorbidities and functional limitation with respect to the relationship with self-reported health status scores was not statistically significant, Figure 2 shows the trend in decrement in self-reported health status due to worsening functional status and increasing comorbidity.

Race/ethnicity was among the factors influencing self-reported health status scores. Results of the multivariable analysis revealed that non-Hispanic whites had a significantly higher mean self-reported health status score than both non-Hispanic blacks and Hispanics: 0.86 (95% CI: 0.82, 0.89) for non-Hispanic whites vs. 0.77 (95% CI: 0.73, 0.80) for non-Hispanic blacks and 0.75 (95% CI: 0.71, 0.78) for Hispanics respectively.

Income was also associated with self-reported health status in both the unadjusted and adjusted analyses ($p<0.01$ for both analyses). The multivariable analysis showed an association between gender and self-reported health status ($p=0.03$) but not age and self-reported health status ($p=0.27$). Obesity was associated with lower self-reported health status in the unadjusted analysis ($p<0.01$), but not in the adjusted analysis ($p=0.35$).

Interactions

We did not find evidence that K-L grade modifies the relationship between functional limitation and self-reported health status as the interaction between K-L grade and knee pain was not statistically significant in any of the multivariable analyses. In fact, none of the interactions that we tested were statistically significant in any of the multivariable regression models.

Discussion

We conducted an analysis to determine correlates of self-reported health status in individuals with radiographic knee OA among NHANES III participants. While we found clear evidence that a greater number of comorbidities and a higher degree of functional limitation were associated with worse self-reported health status, neither radiographic severity of OA nor knee pain influenced self-reported health status in analyses that adjusted for functional status. Further, we did not find evidence of modification of the effect of knee pain on self-reported health status by K-L grade. That is, while radiographs provide the most widely acknowledged indicator of OA severity, this parameter did not appear to influence self-reported health status in our sample. While the fact that we found an association between functional limitation and self-reported health status was not surprising, the magnitude of the decrement in self-reported health status for those with two functional limitations was quite striking. We also found that demographic and socio-economic factors

including non-white race and lower income were also associated with lower self-reported health status in all three multivariable regression models.

Obese participants had on average lower self-reported health status scores than non-obese persons in the unadjusted analysis (0.83 vs. 0.78 respectively; $p < 0.01$). This relationship was not seen when adjusting for the other factors in the model ($p = 0.35$). This is most likely due to two reasons: 1) the fact that obese participants also experience some of the comorbidities that we accounted for in our summative comorbidity index, and 2) the fact that obesity is correlated with other factors in the model (e.g. functional status), leaving no additional variance in the self-reported health status score to be explained by obesity after adjusting for the variables that were included in the multiple regression model. Lastly, we examined interactions involving functional limitation, knee pain, radiographic severity, obesity, comorbidity, and gender, but we were unable to find any that further explained the variability in self-reported health status.

To the best of our knowledge there are no studies evaluating correlates of self-reported health status in a population-based sample of individuals with evidence of radiographic knee OA. The Beaver Dam Health Outcomes Study derived age-adjusted mean estimates of a true health utility using the time-trade-off technique in patients with arthritis, but not specifically radiographic knee OA.⁶ In their age-adjusted analysis, which adjusted for the mean age of 64.1 years in their sample, they found that those with arthritis had a health utility of 0.82 with a 95% confidence interval of (0.80, 0.83).⁶ This result was consistent with the overall mean self-reported health status score (0.81) that we described in this report even though the mean age in our sample is 73 years. This is due to the fact that age was not associated with self-reported health status in two of our analyses. The association seen between age and our ordinal self-reported health status outcome is likely due to a healthy survivor effect since patients age 80 and older were more likely to report being in better health than those who were between the ages of 60 and 65. The advantage of our study is that it provides more detailed information about factors that are associated with self-reported health status in patients with knee OA that allows further discrimination of self-reported health status among persons with knee OA.

Our results are consistent with other studies that examined the impact of race and income on self-reported health status.^{7, 17-19} The study using subjects enrolled in Pennsylvania's Pharmaceutical Assistance Contract for the Elderly (PACE) demonstrated findings similar to what we found with regard to race, income, and comorbidities but not age. The authors analyzed the general health status question as a dichotomous variable (excellent, very good, or good vs. fair or poor) as well.⁷ Subjects age 85 or older were more likely to respond as having fair or poor health than those between the ages of 65 and 74, but they were less likely to respond as having fair or poor health than those between the ages of 75 and 84.⁷ The authors also found that non-white race, lower income, and more comorbidities were associated with worse self-reported health status⁷, which is concordant with our results. However, our sample is a national sample, while PACE is restricted to residents in Pennsylvania. Also, our additional use of a continuous measure allows for further discrimination and estimates that can be used in economic evaluations.

There are several limitations to our study, including that the estimates provided in this manuscript are not population-based estimates. One is that NHANES III used non-weight bearing knee radiographs. This may underestimate the presence and severity of radiographic knee OA²⁰ and could potentially reduce the influence of radiographic severity on self-reported health status. Also, patellofemoral OA is not assessed formally in the K-L grading system. Since patellofemoral OA may be quite painful, this may adversely influence self-reported health status. We acknowledge that the cumulative logit regression model may not

meet the proportional odds assumption in this case. However, since the test for proportionality of odds can be overly sensitive in the presence of large samples we used it as a secondary analysis that confirmed many of the same relationships as ordinary logistic regression. Another limitation of this study is that we were not able to determine causality or observe how self-reported health status changes over time due to the cross-sectional design. As with any observational study, we acknowledge the possibility of not accounting for other confounders which may explain additional variability in self-reported health status. This includes OA in other joints, which were not formally ascertained in NHANES III. It would be important to study the effect of changes in disease severity, symptoms, and comorbidities on changes in self-reported health status over time. We recognize that estimating the effect of missing obesity status and income on self-reported health status may lead to biased estimates with respect to these two variables if the data is not missing completely at random. We acknowledge that our continuous outcome (the transformed rating scale) is an estimate and not a directly elicited Standard Gamble utility.¹² Further research should be done in samples in which utilities would be elicited using direct assessment. Lastly, we recognize that the various comorbidities included in our summative index may not be equally contributing to one's self-reported health status. However, creating a single comorbidity index with equal weights seemed to provide adequate adjustment in our model while accounting for the fact that each comorbidity was relatively rare. This simplification, which has been done in other studies looking at the impact of comorbidity on self-reported health status⁴, would result in a conservative bias, making it more difficult to detect the influence of comorbidities on self-reported health status.

We found that more comorbidities, a higher degree of functional limitation, non-white race, and lower income were associated with a worse self-reported health status in this sample of participants with radiographic knee OA. These results point to subpopulations of patients with knee OA at risk for experiencing worse health. From a clinical point of view, health enhancing interventions could be aimed especially at these subpopulations. From a research standpoint, these patient characteristics should be noted as potential confounders in studies of self-reported health status in knee OA. Further research needs to be done to evaluate how self-reported health status changes in patients as their disease severity and symptoms progress or recede.

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References

1. Parmet S, Lynn C, Glass RM. JAMA patient page. Osteoarthritis of the knee. JAMA. 2003; 289:1068. [PubMed: 12597762]
2. Peat G, McCarney R, Croft P. Knee pain and osteoarthritis in older adults: a review of community burden and current use of primary health care. Ann Rheum Dis. 2001; 60:91–7. [PubMed: 11156538]
3. Torrance GW. Utility approach to measuring health-related quality of life. J Chronic Dis. 1987; 40:593–603. [PubMed: 3298297]
4. Cott CA, Gignac MA, Badley EM. Determinants of self rated health for Canadians with chronic disease and disability. J Epidemiol Community Health. 1999; 53:731–6. [PubMed: 10656104]
5. Manor O, Matthews S, Power C. Dichotomous or categorical response? Analysing self-rated health and lifetime social class. Int J Epidemiol. 2000; 29:149–57. [PubMed: 10750617]
6. Fryback DG, Dasbach EJ, Klein R, et al. The Beaver Dam Health Outcomes Study: initial catalog of health-state quality factors. Med Decis Making. 1993; 13:89–102. [PubMed: 8483408]

7. Dominick KL, Ahern FM, Gold CH, Heller DA. Health-related quality of life among older adults with arthritis. *Health Qual Life Outcomes*. 2004; 2:5. [PubMed: 14720300]
8. Plan and operation of the Third National Health and Nutrition Examination Survey, 1988-94. Series 1: programs and collection procedures. *Vital Health Stat 1*. 1994;1-407.
9. U.S. Department of Health and Human Services (DHHS). National Center for Health Statistics. Third National Health and Nutritional Examination Survey, 1988-1994, NHANES III Knee Osteoarthritis X-ray Data File. Centers for Disease Control and Prevention; Hyattsville, MD: 2001. series 11, no. 11A
10. Kellgren, JH.; Lawrence, JS., editors. *The Epidemiology of Chronic Rheumatism, Atlas of Standard Radiographs*. Blackwell Scientific; Oxford: 1963.
11. Diehr P, Patrick DL, Spertus J, Kiefe CI, McDonell M, Fihn SD. Transforming self-rated health and the SF-36 scales to include death and improve interpretability. *Med Care*. 2001; 39:670-80. [PubMed: 11458132]
12. Torrance GW, Feeny DH, Furlong WJ, Barr RD, Zhang Y, Wang Q. Multiattribute utility function for a comprehensive health status classification system. *Health Utilities Index Mark 2*. *Med Care*. 1996; 34:702-22. [PubMed: 8676608]
13. WHO: World Health Organization [Internet]. City: World Health Organization; Global database on body mass index. [cited 2008 Aug 19]; Available from: http://www.who.int/bmi/index.jsp?introPage=intro_3.html
14. Scheffe H. A Method for Judging all Contrasts in the Analysis of Variance. *Biometrika*. Jun; 1953 40(1):87-104.
15. Korn EL, Graubard BI. Epidemiologic studies utilizing surveys: accounting for the sampling design. *Am J Public Health*. 1991; 81:1166-73. [PubMed: 1951829]
16. Korn EL, Graubard BI. Analysis of Large Health Surveys: Accounting for the Sampling Design. *Journal of the Royal Statistical Society Series A (Statistics in Society)*. 1995; 158(2):263-95.
17. Gold MR, Muennig P. Measure-dependent variation in burden of disease estimates: implications for policy. *Med Care*. 2002; 40:260-6. [PubMed: 11880798]
18. Kaplan RM, Alcaraz JE, Anderson JP, Weisman M. Quality-adjusted life years lost to arthritis: effects of gender, race, and social class. *Arthritis Care Res*. 1996; 9:473-82. [PubMed: 9136291]
19. Krupski TL, Fink A, Kwan L, et al. Health-related quality-of-life in low-income, uninsured men with prostate cancer. *J Health Care Poor Underserved*. 2005; 16:375-90. [PubMed: 15937399]
20. D'Souza JC, Werner RA, Keyserling WM, et al. Analysis of the Third National Health and Nutrition Examination Survey (NHANES III) using expert ratings of job categories. *Am J Ind Med*. 2008; 51:37-46. [PubMed: 18033730]

Figure 1.
Distribution of the functional limitation index by K-L grade and use of a walking aid.

Figure 2.

Adjusted mean estimates of health-related quality stratified by comorbidities and functional limitation. The error bars represent 95% confidence intervals for the adjusted mean and the width is adjusted using Scheffe's procedure.

Table 1

Demographic features of NHANES III participants with radiographic knee OA

Factor	N(%)
Age	
60-64	181 (17.7%)
65-69	200 (19.6%)
70-74	216 (21.2%)
75-79	159 (15.6%)
80+	265 (26.0%)
Gender	
Female	621 (60.8%)
Male	400 (39.2%)
Race/Ethnicity	
Non-Hispanic White	544 (53.9%)
Non-Hispanic Black	240 (23.8%)
Hispanic	225 (22.3%)
Income	
< \$20K	563 (55.1%)
\$20K-\$35K	211 (20.7%)
\$35K+	150 (14.7%)
Missing	97 (9.5%)
Comorbidities [*]	
0-1	246 (24.1%)
2-3	426 (41.7%)
4+	349 (34.2%)
Obesity Status [†]	
Non-Obese	690 (67.6%)
Obese	255 (25.0%)
Missing	76 (7.4%)
K-L Grade	
II	724 (70.9%)
III	219 (21.5%)
IV	78 (7.6%)
Knee Pain [‡]	
No	647 (63.4%)
Yes	374 (36.6%)
Number of Functional Limitations	
0	374 (36.6%)

Factor	N(%)
1	317 (31.1%)
2	330 (32.3%)

* The summative index of comorbidities include: asthma, chronic bronchitis, emphysema, congestive heart failure, myocardial infarction, stroke, elevated cholesterol, hypertension, diabetes, cancer (including skin cancer), fractures of the hip, wrist, or spine, gout, lupus, osteoporosis, back pain most days for at least one month, goiter, urinary tract infection, pneumonia in the last 12 months, blindness, cataracts, and thyroid disease.

[†] Obesity is defined as BMI ≥ 30 .

[‡] Knee pain is defined as knee pain on most days for the past six weeks.

Table 2

Odds ratios and cumulative odds ratios of correlates of self-reported health status from logistic and cumulative logit regression models for NHANES III participants with radiographic knee OA

	Correlates of fair/poor health status		Correlates of worse health status	
	Odds Ratio	95% Confidence Interval	Cumulative Odds Ratio	95% Confidence Interval
Age				
60-64 Years Old	1.00	--	1.00	--
65-69 Years Old	1.13	0.70, 1.83	0.98	0.67, 1.43
70-74 Years Old	0.79	0.48, 1.30	0.80	0.55, 1.17
75-79 Years Old	0.71	0.41, 1.21	0.68	0.45, 1.03
80+ Years Old	0.75	0.45, 1.24	0.63	0.42, 0.93
Gender				
Female	1.00	--	1.00	--
Male	1.35	0.99, 1.85	1.32	1.03, 1.68
Race/Ethnicity				
Non-Hispanic White	1.00	--	1.00	--
Non-Hispanic Black	2.32	1.56, 3.43	2.15	1.58, 2.93
Hispanic	2.94	1.97, 4.39	2.70	1.96, 3.71
Income				
< \$20K	1.00	--	1.00	--
\$20K-\$35K	0.69	0.47, 1.02	0.69	0.51, 0.93
\$35K+	0.44	0.27, 0.72	0.42	0.30, 0.60
Missing	0.73	0.44, 1.22	0.82	0.55, 1.23
Comorbidities *				
0-1	1.00	--	1.00	--
2-3	2.69	1.76, 4.10	2.23	1.65, 3.01
4+	5.49	3.48, 8.66	4.11	2.94, 5.74
Obesity Status †				
Non-Obese	1.00	--	1.00	--
Obese	1.04	0.73, 1.48	1.14	0.86, 1.51
Missing	1.25	0.71, 2.20	1.70	1.08, 2.70
K-L Grade				
II	1.00	--	1.00	--
III	0.89	0.61, 1.29	0.97	0.72, 1.29
IV	1.41	0.80, 2.47	1.33	0.83, 2.11
Knee Pain ‡				
No	1.00	--	1.00	--
Yes	0.94	0.67, 1.31	1.14	0.88, 1.49
Number of Functional Limitations				
0	1.00	--	1.00	--
1	1.68	1.13, 2.48	1.37	1.02, 1.84

	Correlates of fair/poor health status		Correlates of worse health status	
	Odds Ratio	95% Confidence Interval	Cumulative Odds Ratio	95% Confidence Interval
2	4.42	2.95, 6.64	3.24	2.34, 4.47

Odds ratios come from a multivariable logistic regression model where the probability of fair or poor health is being modeled. Odds ratios greater than 1 are associated with being in fair or poor health. Cumulative odds ratios come from the multivariable cumulative logit regression model. Cumulative odds ratios greater than 1 are associated with worse self-reported health.

* The summative index of comorbidities include: asthma, chronic bronchitis, emphysema, congestive heart failure, myocardial infarction, stroke, elevated cholesterol, hypertension, diabetes, cancer (including skin cancer), fractures of the hip, wrist, or spine, gout, lupus, osteoporosis, back pain most days for at least one month, goiter, urinary tract infection, pneumonia in the last 12 months, blindness, cataracts, and thyroid disease.

[†] Obesity is defined as BMI ≥ 30 .

[‡] Knee pain is defined as knee pain on most days for the past six weeks.

Table 3

Unadjusted and adjusted mean self-reported health scores (0-1 scale; 0=worst, 1=best) for NHANES III participants with radiographic knee OA

Unadjusted					Adjusted		
	Mean (SD)	95% Confidence Interval	p-value	Mean	95% Confidence Interval	p-value	
Age							
60-64 Years Old	0.81 (0.25)	0.75, 0.87	0.66	0.77	0.73, 0.81	0.27	
65-69 Years Old	0.80 (0.24)	0.74, 0.85		0.77	0.73, 0.80		
70-74 Years Old	0.82 (0.24)	0.77, 0.88		0.80	0.76, 0.84		
75-79 Years Old	0.80 (0.25)	0.74, 0.87		0.81	0.77, 0.85		
80+ Years Old	0.82 (0.24)	0.77, 0.87		0.80	0.77, 0.84		
Gender							
Female	0.81 (0.25)	0.79, 0.83	0.55	0.81	0.78, 0.83	0.03	
Male	0.82 (0.24)	0.79, 0.84		0.77	0.74, 0.81		
Race/Ethnicity							
Non-Hispanic White	0.86 (0.22)	0.83, 0.89	<0.01	0.86	0.82, 0.89	<0.01	
Non-Hispanic Black	0.77 (0.26)	0.73, 0.81		0.77	0.73, 0.80		
Hispanic	0.74 (0.26)	0.70, 0.79		0.75	0.71, 0.78		
Income							
<\$20K	0.77 (0.26)	0.74, 0.80	<0.01	0.75	0.73, 0.78	<0.01	
\$20K-\$35K	0.85 (0.22)	0.80, 0.90		0.80	0.76, 0.83		
\$35K+	0.91 (0.17)	0.85, 0.97		0.83	0.79, 0.87		
Missing	0.80 (0.25)	0.73, 0.88		0.78	0.73, 0.83		
Comorbidities [*]							
0-1	0.90 (0.18)	0.86, 0.95	<0.01	0.87	0.84, 0.91	<0.01	
2-3	0.82 (0.24)	0.79, 0.86		0.79	0.76, 0.82		
4+	0.73 (0.26)	0.70, 0.77		0.71	0.68, 0.75		
Obesity Status [†]							
Non-Obese	0.83 (0.23)	0.81, 0.86	<0.01	0.80	0.78, 0.83	0.35	

	Unadjusted				Adjusted			
	Mean (SD)	95% Confidence Interval	p-value		Mean	95% Confidence Interval	p-value	
Obese	0.78 (0.25)	0.74, 0.83			0.80	0.77, 0.84		
Missing	0.72 (0.28)	0.65, 0.80			0.76	0.71, 0.82		
K-L Grade			0.01					0.21
II	0.82 (0.24)	0.80, 0.85			0.80	0.77, 0.82		
III	0.81 (0.24)	0.76, 0.86			0.81	0.78, 0.85		
IV	0.73 (0.27)	0.66, 0.81			0.76	0.71, 0.81		
Knee Pain [‡]			<0.01					0.71
No	0.84 (0.23)	(0.82, 0.86)			0.79	0.76, 0.82		
Yes	0.76 (0.26)	(0.73, 0.79)			0.79	0.76, 0.82		
Number of Functional Limitations			<0.01					<0.01
0	0.89 (0.19)	0.86, 0.93			0.85	0.82, 0.89		
1	0.84 (0.22)	0.80, 0.87			0.82	0.78, 0.85		
2	0.70 (0.27)	0.66, 0.73			0.70	0.67, 0.73		

Unadjusted mean estimates of the self-reported health status score come from independent sample's t-test when the variable has two levels and from one-way analysis of variance when the variable has three or more levels. Adjusted mean estimates of the self-reported health status score come from the multivariable linear regression model. The confidence intervals are adjusted for multiple comparisons using Scheffe's procedure for both the unadjusted and adjusted analyses.

* The summative index of comorbidities include: asthma, chronic bronchitis, emphysema, congestive heart failure, myocardial infarction, stroke, elevated cholesterol, hypertension, diabetes, cancer (including skin cancer), fractures of the hip, wrist, or spine, gout, lupus, osteoporosis, back pain most days for at least one month, goiter, urinary tract infection, pneumonia in the last 12 months, blindness, cataracts, and thyroid disease.

[‡] Obesity is defined as BMI $\geq$ 30.

[‡] Knee pain is defined as knee pain on most days for the past six weeks.