

Osteoarthritis and Cartilage



Evaluation of weight loss counsel for Osteoarthritis patients: A cross-sectional analysis of NHANES 2011–2018



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SUMMARY

Objective: Though health care providers (HCPs) know the importance of weight loss counsel for Osteoarthritis (OA), little is known about how frequently it is practiced and even less of its effectiveness. Thus, we analyzed the prevalence and effectiveness of weight counsel receipt in overweight/obese OA patients.

Design: Using 2011–2018 National Health and Nutrition Examination Survey data, we cross-sectionally analyzed overweight/obese patients in the United States to determine the prevalence of receipt of HCP weight counsel in those with OA and among other variables. We used multivariate logistic regression models to calculate odds ratios of being counseled and of achieving ten percent weight loss in groups with and without counsel. Mean weight losses were also compared among groups.

Results: 39,156 patients were identified, of whom 1948 met inclusion criteria. Overall, 51.89% of overweight/obese OA patients received weight counseling. The odds of receiving counsel varied with several demographic variables. The odds of achieving 10% weight loss in those counseled was 1.84 times (95% confidence interval: 1.028, 3.299) that of those not counseled ($p = 0.04$). In contrast, patients counseled lost a mean of 0.49 pounds while those not counseled gained a mean of 0.03 pounds, a difference which was not statistically significant ($p = 0.59$).

Conclusion: Prevalence of weight counsel receipt for OA has not changed significantly between 2011 and 2018. Though counsel for weight more frequently leads to adequate weight loss in those with OA, the average weight loss is minimal regardless of counsel. Thus, refinement of this intervention may be needed to bolster weight loss.

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Introduction

Osteoarthritis (OA) is a mechanical and biological disorder of the joints involving dynamic degeneration of the articular cartilage, subchondral bone, and other surrounding structures.¹ Though OA can affect several joints, the most common and most studied are the hip and the knee. In a recent Global Burden of Disease Study, it was determined that the incidence rate of radiographically diagnosed hip

and knee OA increased by 8.2% since 1990.² This mark is thought to have increased due to the aging population in the United States (U.S.) along with elevated levels of obesity.^{3,4} Other known risk factors for the development of this disease include female sex,⁵ previous knee injuries such as anterior cruciate ligament rupture,⁶ as well as genetic factors.

Though considerable research studying OA has led to an understanding of its common risk factors, the pathophysiologic mechanisms at play remain to be adequately characterized. Other factors making OA difficult to understand are its insidious symptom onset and a lack of clinical correlation to objective signs seen on imaging.⁷ In the case of those with obesity and knee arthritis, for instance, it is theorized that excessive mechanical loads on the tibiofemoral cartilage result in damage.⁸ However, obesity's established relationship with OA in the case

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of joints less susceptible to these loads suggests that other factors related to obesity such as systemic inflammation may cause OA.

Despite the high prevalence and burden of this disease on our society, there are no approved drugs to reverse its typical degenerative course. Management therefore focuses on the symptoms of the disease to decrease pain and improve function. The definitive treatment for end-stage OA often includes the widely successful total joint arthroplasty procedure. However, due to an increased risk of several peri- and postoperative complications associated with morbid obesity, this procedure is frequently not performed until body mass index (BMI) is below 40.^{9–13} In a recent review of guidelines from several major orthopedic and rheumatologic societies, the most widely recommended management strategies for OA were discussed.¹⁴ Weight loss, exercise, or a combination of these are frequently and strongly suggested in both hip and knee arthritis. Regarding weight loss specifically, evidence supports that an appropriate goal for patients is loss of 10% of body weight to significantly reduce pain in patients with OA who are overweight or obese.^{15,16} To help patients achieve this goal, the National Institutes of Health has published BMI-specific caloric reduction and exercise regimen guidelines.¹⁷

Research has shown that counseling from physicians regarding lifestyle modifications such as weight loss and exercise leads to increased engagement,^{18,19} yet more than half of overweight or obese patients in the U.S. have not received such counsel.²⁰ In previous literature, it was apparent that patient factors such as male sex, lower income, and education lead to decreased reception of these recommendations from their doctors.^{21,22} Given that these are keys to improving OA outcomes in those who are overweight or obese and may not be surgical candidates, there is a need to characterize the frequency with which this guidance is received. A study examining data from 2002 to 2014 indicated that the prevalence of weight loss counsel to patients with any arthritis increased from 35.1% to 45.5%.²³ Regarding OA specifically, there is no available data providing similar evaluation. Furthermore, the relationship between receiving and following advice remains unknown, especially in this population of OA patients. Thus, in this study, we sought to analyze the prevalence of receipt of healthcare provider (HCP) weight counseling and its effectiveness for patients with OA, hypothesizing both values would be relatively low in magnitude. To investigate these, we used a sample of patients with OA from the National Health and Nutrition Examination Survey (NHANES) data gathered by the National Center for Health Statistics (NCHS) from 2011 to 2018 and performed a cross-sectional analysis of these treatment recommendations.

Method

Data source

The NHANES is an NCHS program and database that is freely accessible to the public and cross-sectionally analyzes the health and nutrition statuses of a nationally representative sample of non-institutionalized American civilians. The NHANES study protocol utilizes a complex multistage probability sampling design to obtain its nationally representative sample for both interview and examination components. Study teams consist of a physician, medical technicians, and dietary or other health staff who collect interviews, physical examinations, and laboratory data. Data are collected throughout the duration of each year in several areas of the U.S. from either household interviews in which patients self-report information or from mobile examination centers. These gathered data are then reported every two years. NHANES has been approved by the NCHS Research Ethics Review Board and all adult participants provided written informed consent.

Participant identification

This large dataset was queried from a combination of four discrete two-year cycles from 2011 to 2012 through 2017–2018 to identify adult overweight or obese patients with OA for inclusion. Participants initially excluded from this cross-sectional analysis were those below the age of 20 due to NHANES data limitations and those with a BMI below 25 as these patients did not meet criteria to be overweight or obese. Survey participants who refused to answer or did not know the answer to a question used for identification were categorized as missing data and excluded. Participants found to otherwise have been missing data due to inherent survey features such as criteria-based exclusion from certain questions or skip patterns were also excluded. Participants were then identified using the Medical Condition Questionnaire which asks NHANES participants, "Has a doctor or other health professional ever told (you/sample participant) that (you/sample participant) had arthritis?". Those that answered "yes" received a follow-up question asking, "What type of arthritis was it?". Using responses to these two questions, participants with diagnosed OA were identified from the overall sample for further analysis.

Measures

Receipt of counsel

From the Medical Condition Questionnaire, answers to the following question were assessed: "To lower {your/sample patient's} risk for certain diseases, during the past 12 months {have you/has s/he} ever been told by a doctor or health professional to: control {your/his/her} weight or lose weight?". Responses to this question were used to obtain the percentage of individuals that received weight counseling among various groups.

Response to counsel

To determine the effectiveness of weight counseling, the quantity of weight change was calculated by subtracting from participants' measured weights at the time of NHANES physical exam their self-reported weights from one year prior. The value of weight change was categorized as greater than or less than ten percent of the self-reported weight from one year prior. The one-year period of observation for weight change coincided with the one-year period in which participants were either counseled about their weight or not. Weight changes and whether participants achieved ten percent weight loss were determined for two groups of OA patients – one consisting of those who received weight counsel and the other of those who did not.

Covariates

Covariates for multivariate analysis were selected by assessing those used in previous studies with similar methodologies.^{23,24} These included demographic variables such as sex, age, education, race, BMI, and family income to poverty level ratio (PIR). These variables were available from NHANES interviews or physical examination data in the case of BMI. Available categories for education included: less than 9th grade, 9th–11th grade (includes 12th grade with no diploma), high school graduate/GED or equivalent, some college or associate degree, and college graduate or above. Race was categorized as White, Black, Mexican American, other Hispanic, Asian, or other race. For analytical purposes, continuous variables such as BMI and PIR were converted to categorical variables as needed. BMI was categorized as: 25–29.99 (overweight), 30–34.99 (obesity class I), 35–39.99 (obesity class II), and 40+ (obesity class III)²⁵ while PIR was categorized as: < 1 (below the poverty line), 1–3.49, and ≤ 3.5 which were similar to those reported in an NCHS study.²⁶

Statistical analysis

To address the effects of complex survey design, a combination of multiple sequential cycles in NHANES, and non-response to survey items, statistical analyses were performed with adjustment using sample weights according to NHANES analytic guidelines.²⁷ Descriptive statistical analysis determined weighted means $\pm$ Standard Error (SE) along with 95% confidence intervals (CI) for continuous variables and frequencies with weighted percentages for categorical variables. Due to inequality of variance within the distributions of weight change for participants counseled for weight and not counseled for weight, Welch's unpaired parametric t-test was performed to obtain p-values. Chi-squared testing with Yates' correction was performed to determine if there was a statistically significant relationship between achieving ten percent weight loss in those with OA depending on receipt of counsel. Adjusted odds ratios (OR) were also determined, and Woolf-logit CIs were computed for this statistic.

Logistic regression modeling was performed for categorical outcomes while incorporating weighting, strata, and cluster variables per NHANES Analytic Guidelines.²⁸ While conditioning on included covariates, these models were used to calculate adjusted OR with 95% CIs and p-values. These regressions were specifically used to determine if there were differences in receipt of HCP weight counseling or achieving ten percent weight loss. Variables included in the model with weight counsel as an outcome were sex, age, race,

education, PIR, and BMI. Weight counsel was added as a variable to a second logistic regression modeling the outcome for achievement of ten percent weight loss in those with OA. Participants with any missing data pertaining to demographic variables included in the regressions were excluded from that analysis. All analyses were performed in SAS V.9.4 (SAS Institute Inc., Cary, NC) using $p < 0.05$ set a priori as an indicator of statistical significance.

Results

Participant selection and demographical composition

39,156 patients were identified in the NHANES database from 2011 to 2018 of whom 23,989 were excluded due to either meeting criteria of age below 20 or BMI below 25. Of the remaining 15,167 participants, 28 more were excluded as they were found to have missing data for the arthritis portion of the questionnaire while 4560 were found to have some form of arthritis and 10,579 had no arthritis. Among the 4560 with arthritis, 1948 were clinically diagnosed with OA while 1358 had another form of arthritis, and 1254 more were excluded due to missing data from not knowing the answer or refusing to answer this question. Therefore, after all exclusions were made during participant selection, there were 13,885 overweight/obese participants in the total sample made up of 1948 (weighted % = 15.87) having OA and the remaining 11,937 (weighted % = 84.13) not having OA (Fig. 1).

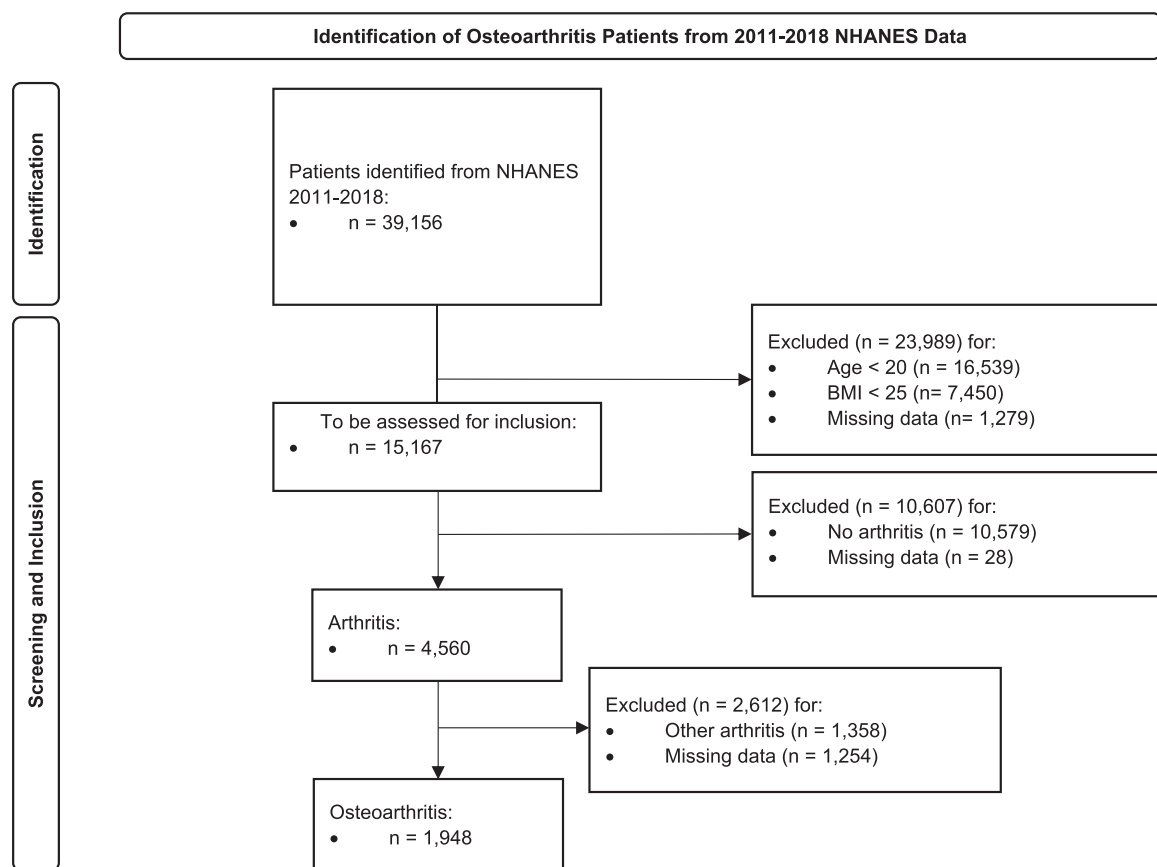


Fig. 1

	Osteoarthritis (n = 1948), n (weighted % of group)	Total (n = 13,885), n (weighted % of group)
Age (years)		
20–29	26 (1.52)	2005 (15.71)
30–39	92 (4.50)	2480 (18.82)
40–49	185 (9.82)	2526 (19.45)
50–59	379 (23.94)	2383 (19.20)
60–69	579 (30.87)	2426 (14.89)
70–79	435 (20.15)	1334 (8.19)
80+	252 (9.21)	731 (3.75)
Weighted Mean +/- SE	61.53+/- 0.29	48.88+/- 0.13
Sex		
Male	705 (36.56)	6861 (50.58)
Female	1243 (63.44)	7024 (49.42)
BMI (kg/m²)		
25–29.99	707 (37.88)	6374 (45.98)
30–34.99	599 (31.70)	4127 (30.07)
35–39.99	325 (15.53)	1887 (13.35)
40+	317 (14.90)	1497 (10.59)
Weighted Mean +/- SE	33.35+/- 0.16	32.15+/- 0.05
Race		
Non-Hispanic White	1084 (80.26)	5064 (63.83)
Non-Hispanic Black	357 (7.27)	3319 (11.89)
Mexican American	179 (3.69)	2229 (10.21)
Other Hispanic	155 (2.94)	1568 (6.88)
Non-Hispanic Asian	80 (1.46)	1196 (3.67)
Other Race - Including Multi-Racial	93 (4.40)	509 (3.52)
Education		
Less than 9th grade	137 (2.94)	1301 (5.07)
9–11th grade (Includes 12th grade with no diploma)	227 (8.21)	1757 (9.16)
High school graduate/GED or equivalent	427 (21.98)	3155 (23.42)
Some college or associate degree	685 (35.58)	4477 (33.36)
College graduate or above	469 (31.29)	3182 (28.99)
PIR		
< 1	315 (11.11)	2728 (14.56)
1–3.49	886 (41.76)	6102 (43.63)
≥3.5	584 (47.13)	3701 (41.81)
Weighted Mean+/- SE	3.17+/- 0.04	2.97+/- 0.01

BMI = body mass index. GED = general education development. PIR = family income to poverty level ratio. SE = standard error.

Table 1

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Characteristics of all included NHANES participants with age ≥20 and BMI ≥25 from NHANES 2011–2018. n = 13,885. Also shown is the sample of these participants who had OA. n = 1948. Continuous variables were analyzed as such to present weighted mean +/- SE and converted to categories to be presented as frequencies and weighted percentages.

In the entire sample, the weighted mean age was 48.88+/- 0.13 years old with this value in the OA group being 61.53+/- 0.29 years old. The largest proportional age group of OA patients in this sample was the category including those between the age of 60–69 which made up 30.87% of the sample. The weighted proportion of women in this study was 49.42% in the overall sample in comparison to 63.44% in the OA group. In the entire sample, the weighted mean for BMI was 32.15+/- 0.05 kg/m² and 2.97+/- 0.01 for PIR. The majority race of this sample was non-Hispanic White participants making up 63.83%. The majority education group was some college or associate degree comprising 33.36% of the total sample (Table 1).

Changes in receipt of weight counsel by year and patient characteristics

Partitioning the data from 2011 to 2018 into its four biennial groups of 2011–2012, 2013–2014, 2015–2016, and 2017–2018, the

proportion of OA patients who received weight counseling from HCPs ranged from 49.72% (n = 527) to 54.28% (n = 479) with the highest percentage being in the years 2015–2016 (Fig. 2). Over the entire course of 2011–2018, 51.89% (n = 1948) of those with OA had been told to control/lose weight. Proportions of these OA patients counseled for their weight, however, were found to vary to a large degree when stratified by demographic variables (Fig. 3).

As shown in Table II we utilized multivariate logistic regression analysis with weighting to assess the OR of OA participants receiving advice to control/lose weight. Of the 1948 participants with OA, 1785 were included in this regression after exclusion of participants with missing data for demographic variables included in the analysis. Specifically, these 163 participants were excluded due to missing data pertaining to the PIR variable. BMI was found to increase the OR for receiving weight counsel with a value of 1.185 (95% CI: 1.146, 1.225, p < 0.0001). In addition, it was

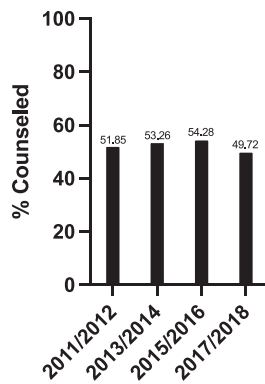


Fig. 2

Osteoarthritis and Cartilage

Percent of participants with OA counseled to control/lose weight in biennial cycles from 2011–2018. SE were calculated as follows but too small to be presented graphically. SE: 2011/2012 = 0.025, 2013/2014 = 0.022, 2015/2016 = 0.023, 2017/2018 = 0.022. SE = Standard Error.

determined that Black participants relative to White participants were the only other covariate in this analysis which had an increased OR of being told to control/lose weight at 1.587 (95% CI: 1.134, 2.221, $p = 0.0078$).

Action on weight counseling

1921 OA patients also had available self-reported weights from one year prior. Among this group, it was discovered that patients who were told to control/lose weight within the previous year ($n = 999$) lost a weighted mean of 0.4895 pounds (95% CI: -1.9914, 1.0124, SE = 0.7654) while those not counseled to do so ($n = 922$) gained a mean of 0.0337 pounds (95% CI: -1.1232, 1.1906, SE = 0.5895) (Fig. 4). The difference in weight loss between those who were counseled for weight and those who were not counseled was found to be insignificant ($p = 0.58882$).

To determine the relationship between weight counsel and achieving adequate weight loss, OA patients in this study were assessed for loss of ten percent of their body weight after receipt of counsel or not. Of the 1948 patients with OA, 205 achieved 10% weight loss with 126 of these having been counseled. Chi-squared testing revealed an OR of 1.662 (95% CI: 1.657, 1.667, $p < 0.0001$) for being told to control or lose weight and achieving the goal of ten percent loss in comparison to not achieving this goal.

Weighted multivariate analysis was performed using 1766 OA participants after exclusion of those with missing variable data. In this regression, 182 participants were excluded for missing information. As in the above analysis, 163 were missing PIR information. An additional 19 participants in this analysis were missing data for weight counsel receipt and excluded. When conditioning upon these other demographic variables including sex, race, education, PIR, age, and BMI, we found a similar increased odds ratio of 1.842 (95% CI: 1.028, 3.299, $p = 0.0404$) for achieving ten percent weight loss in comparison to not meeting this goal (Table III). This portion of the analysis also revealed that the ORs of achieving ten percent body weight loss decreased with age (OR=0.98, 95% CI: 0.968, 0.993), ($p = 0.0024$) and with PIR (OR=0.815, 95% CI: 0.707, 0.939), ($p = 0.0054$). Last, there was

a significant elevation in the odds of achieving this outcome for those in the other race category compared to the White category (OR=3.313, 95% CI: 1.134, 9.679), ($p = 0.0291$).

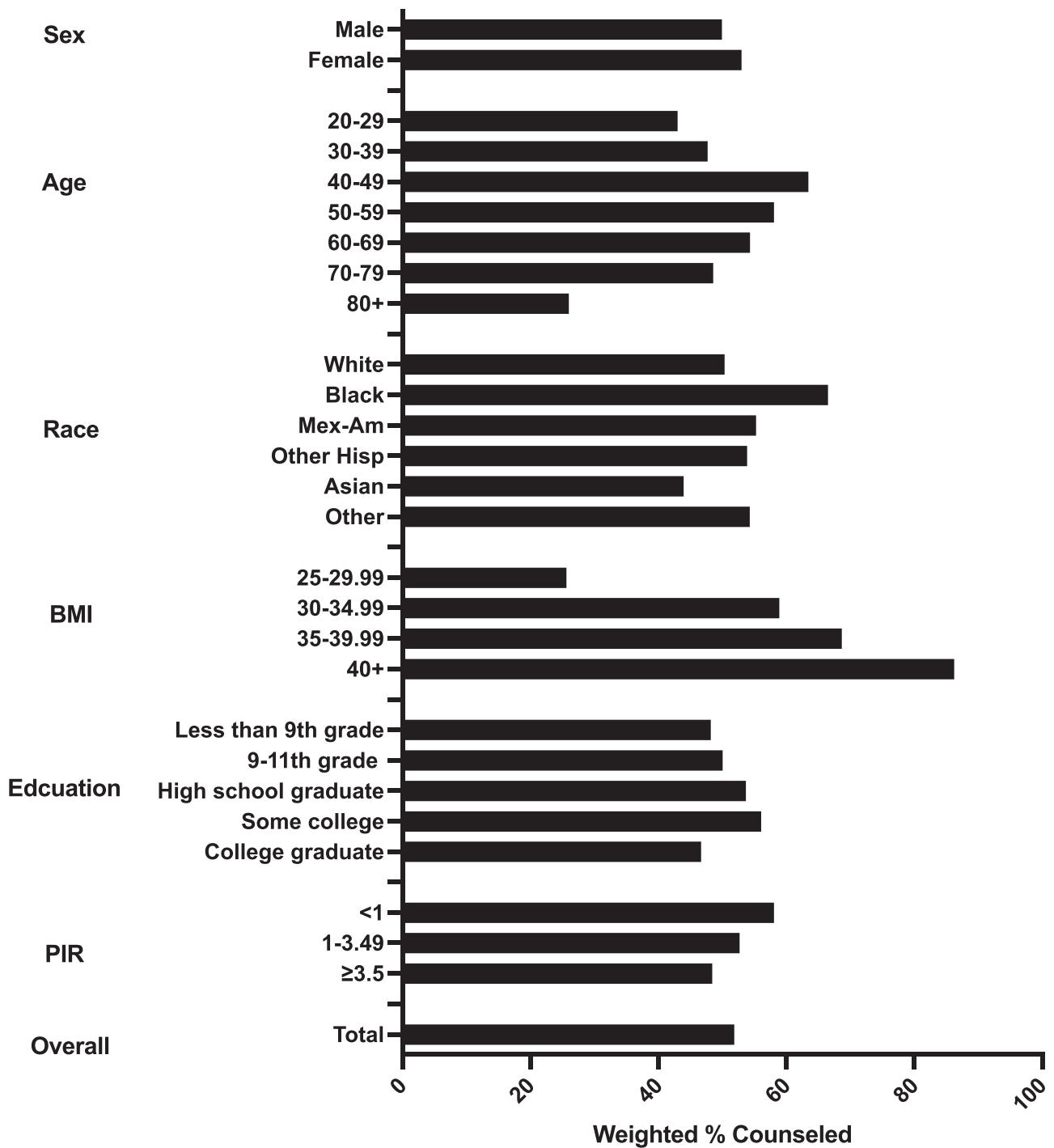
Discussion

This is the largest study cross-sectionally analyzing the prevalence and effectiveness of HCP weight counseling receipt in overweight/obese OA patients. The sample obtained from NHANES 2011–2018 data was representative of the non-institutionalized overweight and obese U.S. population over the age of 20 years old. We found that of 13,885 eligible patients, 1948 (weighted% = 15.87) reported having been diagnosed with OA while 11,937 (weighted% = 84.13%) had not. Though in the current literature, prevalence data of self-reported OA specifically in the overweight/obese adult (18 years or older) population is not readily available, studies have indicated a prevalence of self-reported doctor-diagnosed OA ranging between 11.9%–18.4%.^{29,30}

Weight counsel of overweight/obese OA patients surpassed 49.72% in each biennial cycle that was measured with the overall percentage over 8 years being 51.89%. Healthy People 2020, which identified quantifiable objectives for health promotion and disease prevention by the year 2020, created a target for weight loss counsel of 45.3% of overweight or obese arthritis patients.³¹ Using this guideline as a crude standard as it was developed for the broader category of arthritis, the data from this study of patients between 2011 and 2018 indicate that this figure was consistently met in each biennial cycle and in aggregate. However, when assessing the proportions of those counseled in certain demographics, this is no longer the case. For instance, OA patients who fall in the overweight category per their BMI only received counsel for their weight 25.63% of the time. This figure demonstrates that overweight OA patients remain severely undermanaged as it pertains to their weight. Also, receipt of counsel in those with ages at the lower (20–29 years) and higher (80+ years) ends of the analysis fell below the standard posed by Healthy People.

Among the variables associated with significant differences in the OR of receiving counsel for weight seen in those with OA were BMI and Black race. It is likely that the breadth of literature demonstrating both association between BMI and OA along with the effectiveness of weight loss for management are involved with this increase in counseling for those with higher BMIs. The evidence in this study however that Black participants with OA have increased odds of receiving counseling for weight with respect to White counterparts is novel. A previous study examining the prevalence of weight loss counsel in patients with any form of arthritis between 2002 and 2014 indicated no significant difference between White participants and Black participants.²³ Yet, the finding that overweight/obese Black patients receive proportionally elevated counseling for weight is not new. It has been proposed that this observation is due to increased awareness of obesity in Black patients who have been shown to have a near 10% increase in prevalence of obesity versus White participants.^{24,32} In this case however, there is no explanation for this outcome not being observed in Hispanic or Mexican American participants as those recorded as Hispanic had the greatest prevalence of obesity in the study by Hales, et al.

As stated previously, once patients receive advice from their HCP to control/lose weight, little is known about the success they have attaining this goal. One study used self-management class attendance after weight loss counsel to gauge this³³ while others have asked patients directly if they would or have changed their weight due to counseling.³⁴ In this study we subtracted participants' self-reported weights from one year prior from their examination

**Fig. 3**

Weighted percent of participants with OA counseled to control/lose weight stratified by demographic variables. White = non-Hispanic White. Black = non-Hispanic Black. Mex-Am = Mexican American. Other Hisp = Other Hispanic. Asian = non-Hispanic Asian. Other = other race (including multi-racial). BMI = body mass index (measured in kg/m^2). 9th-11th grade includes 12th grade with no diploma. High school graduate includes those with GED or other equivalent. Some college includes associate degree. College graduate includes those with more advanced degrees. PIR = family income to poverty ratio.

	Adjusted Odds Ratio for Receipt of Counsel	Lower bound for 95% CI	Upper bound for 95% CI	p-value
Sex				
Male	Ref			
Female	0.972	0.725	1.303	0.8468
Race				
Non-Hispanic White	Ref			
Non-Hispanic Black	1.587	1.134	2.221	0.0078*
Mexican American	1.134	0.7	1.839	0.604
Other Hispanic	1.077	0.691	1.677	0.7406
Non-Hispanic Asian	1.218	0.685	2.165	0.4952
Other Race - Including Multi-Racial	1.018	0.454	2.283	0.964
Education				
Less than 9th Grade	Ref			
9–11th grade (Includes 12th grade with no diploma)	1.071	0.581	1.973	0.8239
High school graduate/GED or equivalent	1.268	0.732	2.198	0.3913
Some college or associate degree	1.212	0.762	1.926	0.4111
College graduate or above	1.123	0.696	1.811	0.6302
PIR	1.021	0.923	1.129	0.6839
Age (years)	0.994	0.985	1.004	0.2314
BMI (kg/m²)	1.185	1.146	1.225	< 0.0001*

PIR= family income to poverty level ratio. BMI= body mass index. CI= confidence interval

* statistical significance (p < 0.05).

Table II

Osteoarthritis and Cartilage

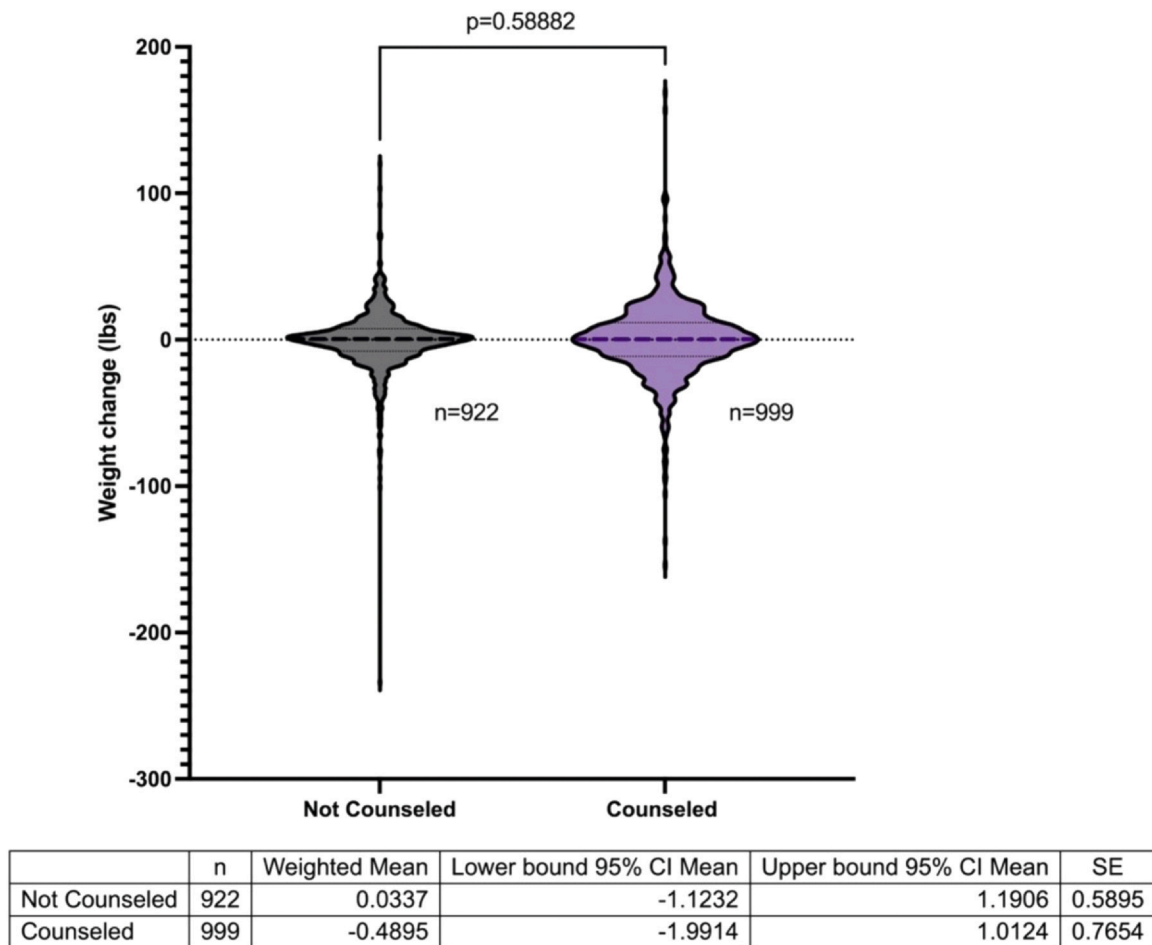
Adjusted OR of being counseled to control/lose weight in those with OA across variables age, sex, race, education, PIR, age, and BMI using a reference group for each categorical variable. n = 1785. Adjusted OR were determined using PROC SURVEYLOGISTIC in SAS adjusting for all variables in the table along with survey weight, strata, and cluster variables.

weights to obtain the weight change over a year. This method was not without flaws as self-reported weights are subject to several biases, namely, recall and/or social desirability. Also, there was no guarantee that patients received counsel with enough time to achieve weight loss prior to their weight measurement being taken. Using this weight change as an outcome metric after being counseled to control/lose weight or not, we found that OA patients lost minimal weight regardless of counseling. When counseled, patients lost a mean of 0.4895 pounds and when not counseled, they gained a mean of 0.0337 pounds. Further statistical analysis of this demonstrated that these changes in weight were statistically insignificant. This finding that weight counsel made no impact on weight change is concerning and indicates low effectiveness of this non-operative form of OA management as it is practiced currently. However, as the specific methods used to provide weight counseling to each of the patients in this study were unknown, there may have been great variability between the characteristics of the counseling they received. It is widely accepted that long-term weight management requires persisting and/or repetitive interventions from either physicians, dieticians, or other HCPs.³⁵ Therefore, without comprehensive counsel such as this, it is unlikely that patients lose adequate weight to have a beneficial effect on their OA.

Importantly for those with OA, there is a recommended minimum proportion of weight loss of 10% to provide clinical benefits.¹⁶ A meta-analysis from 2021 showed that pain, function, and stiffness scores only increase by 2% with each percent of one's weight that is lost.³⁶ Given that a 20% improvement in pain level is needed for clinical significance of an intervention,³⁷ it can be calculated that 10% of weight loss is necessary.³⁸ Using the weight

change metric described before, we made an additional calculation in this study to determine if patients had reached the mark of 10% weight loss from their weight one year ago. Again, there are limitations with using this weight change metric in that we do not know the exact time at which a participant was diagnosed with OA or counseled for their weight other than within the past year. This being the case, we found that the odds ratio of losing 10% of baseline weight was 1.662 (95% CI: 1.657, 1.667) in those counseled compared to those not counseled. Using logistic regression models controlling for several other factors, this odds ratio increased in magnitude to 1.842 but had much less precision per its 95% CI. Last, it was shown that the odds of reaching 10% of one's baseline weight is subject to differences in age, PIR, and race. While increases in age or PIR were associated with reduced odds of achieving 10% weight loss, those categorized in the other race group were shown to have elevated odds. Further studies may be needed to assess these relationships with more clarity.

As mentioned throughout, this study was not without significant limitations. In addition to the imperfect outcome measurements created with finite NHANES variables, there were also more general issues in this study design to report. The lack of detailed information regarding HCP weight counseling sessions made interpretation of our findings challenging in some regards. Regarding the measurements of counsel effectiveness, the main deficiencies of this study were the unknown timing of counsel in relation to the examination of participant weights and the possibility that patients never met with an HCP to receive counsel for weight. These factors make it difficult to reasonably expect some participants in the study to achieve the weight loss outcomes that we assessed and may have led

**Fig. 4**

Amount of weight change in pounds observed between OA participants' self-reported weights from one year prior and the actual weight at NHANES examination depending on receipt of weight counsel. $n = 1921$. Weight changes are presented with weighted means, 95% CI of these means, and SE. Presented p -value was determined from Welch's unpaired parametric T-test. lbs = pounds. CI = confidence interval. SE = standard error.

to an underestimation of weight loss upon counsel. We also did not know the additional factors aside from counsel that may have contributed to any observed weight changes or which specialty counseled them. There are known differences in the amount and quality of weight counseling that is performed by certain specialties³⁹ including orthopedics which is known to engage significantly less with this kind of management.⁴⁰ Last, there was no way to further divide the group of OA patients into those who would have gained significant benefit from weight loss, i.e., those with knee or hip OA as opposed to hand OA. Altogether, the significant limitations of this study indicate that further research with supplementary controlled variables may be needed to validate our exploratory findings.

In sum, the results of this cross-sectional analysis demonstrated that HCP counseling for adult OA patients with a BMI over 25 has met previously determined targets, but not for those in the overweight category. In addition, we demonstrated that weight loss upon weight counseling of OA patients is both minimal and like those who were

not counseled. While this may be the case, we closed this study showing that OA patients counseled for their weight had greater odds of achieving clinically significant weight loss than those who received no counsel. Taken together, this suggests that while these practices have increased over the years and have effectiveness in some instances, ineffective methods of counseling seem to be commonplace and often make very little difference. Given the tremendous number of patients who suffer from OA and its burden on our healthcare system, we need to focus more on the practical aspects of effective weight loss counsel. On the other hand, the success of new anti-obesity medications such as semaglutide, which provide marked weight loss when combined with lifestyle modifications,⁴¹ may indicate that clinical weight management is changing. Thus, in addition to the continued monitoring of standard physician weight counseling of those with OA, it appears that it may also be relevant to study the effectiveness of several other weight management plans in the future.

	Adjusted Odds Ratio for Achieving 10% Weight Loss	Upper bound for 95% CI	Lower bound for 95% CI	p-value
Weight counsel				
No	Ref			
Yes	1.842	1.028	3.299	0.0404*
Sex				
Male	Ref			
Female	1.119	0.713	1.755	0.6197
Race				
Non-Hispanic White	Ref			
Non-Hispanic Black	1.035	0.632	1.693	0.8903
Mexican American	1.585	0.856	2.934	0.1399
Other Hispanic	0.991	0.506	1.941	0.9796
Non-Hispanic Asian	0.512	0.16	1.636	0.254
Other Race - Including Multi-Racial	3.313	1.134	9.679	0.0291*
Education				
Less than 9th Grade	Ref			
9–11th grade (Includes 12th grade with no diploma)	0.949	0.474	1.9	0.8804
High school graduate/GED or equivalent	1.059	0.522	2.149	0.8718
Some college or associate degree	0.705	0.349	1.423	0.3236
College graduate or above	0.808	0.367	1.78	0.591
PIR	0.815	0.707	0.939	0.0054*
Age (years)	0.98	0.968	0.993	0.0024*
BMI (kg/m²)	0.949	0.9	1.002	0.059

PIR = family income to poverty level ratio. BMI = body mass index. CI = confidence interval.

* statistical significance (p < 0.05).

Table III

Osteoarthritis and Cartilage

Adjusted OR of achieving ten percent weight loss in those with OA across variables including weight counsel status, age, sex, race, education, PIR, age, and BMI using a reference group for each categorical variable. n=1766. Adjusted OR were determined using PROC SURVEYLOGISTIC in SAS adjusting for all variables in the table along with survey weight, strata, and cluster variables.

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Declaration of Competing Interest

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Declaration of author contributions

Full responsibility of the article: SC. Conception and study design: SC, GK, and AS. Collection and assembly of data: SC. Analysis and interpretation of the data: SC, AS, GK, NI. Drafting of the article: SC. Critical revision of the article: NI, GK, and AS. Final approval of the article: all authors.

References

1. Szponder T, Latalski M, Danielewicz A, Krawiec K, Kozera A, Drzewiecka B, et al. Osteoarthritis: pathogenesis, animal models, and new regenerative therapies. (Published online). J Clin Med2023. <https://doi.org/10.3390/jcm12010005>. (Published online).
2. Safiri S, Kolahi AA, Smith E, Hill C, Bettampadi D, Mansournia MA, et al. Global, regional and national burden of osteoarthritis 1990–2017: a systematic analysis of the Global Burden of Disease Study 2017. (Published online). Ann Rheum Dis2020. <https://doi.org/10.1136/annrheumdis-2019-216515>
3. Palazzo C, Ravaud JF, Papelard A, Ravaud P, Poiraudau S. The burden of musculoskeletal conditions. (Published online). PLoS One2014. <https://doi.org/10.1371/journal.pone.0090633>
4. Birtwhistle R, Morkem R, Peat G, Williamson T, Green ME, Khan S, et al. Prevalence and management of osteoarthritis in primary care: an epidemiologic cohort study from the Canadian Primary Care Sentinel Surveillance Network. CMAJ Open 2015. <https://doi.org/10.9778/cmajo.20150018>. Published online.
5. Franke M, Mancino C, Taraballi F. Reasons for the sex bias in osteoarthritis research: a review of preclinical studies. Int J Mol Sci 2023;24(12):10386. <https://doi.org/10.3390/ijms241210386>
6. Ferrero S, Louvois M, Barnetche T, Breuil V, Roux C. Impact of anterior cruciate ligament surgery on the development of knee osteoarthritis: A systematic literature review and meta-analysis comparing non-surgical and surgical treatments. Osteoarthritis Cartil open 2023;5(3), 100366. <https://doi.org/10.1016/j.ocarto.2023.100366>

7. Anderson JJ, Felson DT. Factors associated with osteoarthritis of the knee in the first national health and nutrition examination survey (Hanes I): Evidence for an association with overweight, race, and physical demands of work. (Published online). *Am J Epidemiol*1988. <https://doi.org/10.1093/oxfordjournals.aje.a114939>
8. Pottie P, Presle N, Terlain B, Netter P, Mainard D, Berenbaum F. Obesity and osteoarthritis: more complex than predicted!. (Published online). *Ann Rheum Dis*2006. <https://doi.org/10.1136/ard.2006.061994>
9. Namba RS, Paxton L, Fithian DC, Stone MLou. Obesity and peri-operative morbidity in total hip and total knee arthroplasty patients. *J Arthroplasty* 2005. <https://doi.org/10.1016/j.arth.2005.04.023>
10. Abdel MP, Bonadurer GF, Jennings MT, Hanssen AD. Increased aseptic tibial failures in patients with a BMI ≥ 35 and well-aligned total knee arthroplasties. (Published online). *J Arthroplasty*2015. <https://doi.org/10.1016/j.arth.2015.06.057>. (Published online).
11. Kerkhoffs GMMJ, Servien E, Dunn W, Dahm D, Bramer JAM, Haverkamp D. The influence of obesity on the complication rate and outcome of total knee arthroplasty. (Published online). *J Bone Jt Surg*2012. <https://doi.org/10.2106/jbjs.k.00820>
12. Takahata K, Arakawa K, Enomoto S, Usami Y, Nogi K, Saitou R, et al. Joint instability causes catabolic enzyme production in chondrocytes prior to synovial cells in novel non-invasive ACL ruptured mouse model. (Published online). *Osteoarthritis Cartil*2023. <https://doi.org/10.1016/j.joca.2022.12.004>
13. DeMik DE, Bedard NA, Dowdle SB, Elkins JM, Brown TS, Gao Y, et al. Complications and obesity in arthroplasty—A hip is not a knee. *J Arthroplasty* 2018. <https://doi.org/10.1016/j.arth.2018.02.073>
14. Overton C, Nelson AE, Neogi T. Osteoarthritis Treatment Guidelines from Six Professional Societies: Similarities and Differences. (Published online). *Rheum Dis Clin North Am*2022. <https://doi.org/10.1016/j.rdc.2022.03.009>
15. Riddle DL, Stratford PW. Body weight changes and corresponding changes in pain and function in persons with symptomatic knee osteoarthritis: a cohort study. (Published online). *Arthritis Care Res*2013. <https://doi.org/10.1002/acr.21692>
16. Christensen R, Astrup A, Bliddal H. Weight loss: the treatment of choice for knee osteoarthritis? A randomized trial. (Published online). *Osteoarthritis Cartil*2005. <https://doi.org/10.1016/j.joca.2004.10.008>
17. Clinical Guidelines on the identification, evaluation, and treatment of overweight and obesity in adults—the evidence report. National Institutes of Health. In: *Obesity Research*; 1998.
18. Pool AC, Kraschnewski JL, Cover LA, Lehman EB, Stuckey HL, Hwang KO, et al. The impact of physician weight discussion on weight loss in US adults. (Published online). *Obes Res Clin Pract*2014. <https://doi.org/10.1016/j.orcp.2013.03.003>
19. Calfas KJ, Long BJ, Sallis JF, Wooten WJ, Pratt M, Patrick K. A controlled trial of physician counseling to promote the adoption of physical activity. (Published online). *Prev Med*1996. <https://doi.org/10.1006/pmed.1996.0050>
20. Sciamanna CN, Tate DF, Lang W, Wing RR. Who reports receiving advice to lose weight? Results from a multistate survey. (Published online). *Arch Intern Med*2000. <https://doi.org/10.1001/archinte.160.15.2334>
21. Ko JY, Brown DR, Galuska DA, Zhang J, Blanck HM, Ainsworth BE. Weight loss advice U.S. obese adults receive from health care professionals. (Published online). *Prev Med*2008. <https://doi.org/10.1016/j.ypmed.2008.09.007>
22. Lorts C, Ohri-Vachaspati P. Disparities in who receives weight-loss advice from a health care provider: does income make a difference. (Published online). *Prev Chronic Dis*2016. <https://doi.org/10.5888/pcd13.160183>
23. Guglielmo D, Hootman JM, Murphy LB, Boring MA, Theis KA, Belay B, et al. Health Care Provider Counseling for Weight Loss Among Adults with Arthritis and Overweight or Obesity — United States, 2002–2014. (Published online). *MMWR Morb Mortal Wkly Rep*2018. <https://doi.org/10.15585/mmwr.mm6717a2>. (Published online).
24. Greaney ML, Cohen SA, Xu F, Ward-Ritacco CL, Riebe D. Healthcare provider counselling for weight management behaviours among adults with overweight or obesity: A cross-sectional analysis of National Health and Nutrition Examination Survey, 2011–2018. (Published online). *BMJ Open*2020. <https://doi.org/10.1136/bmjopen-2020-039295>
25. Weir CB, Jan A. BMI classification percentile and cut off points; 2019.
26. Ogden CL, Lamb MM, Carroll MD, Flegal KM. Obesity and socioeconomic status in children and adolescents: United States, 2005–2008 (Published online). *NCHS Data Brief*2010. (Published online).
27. Akinbami LJ, Chen TC, Davy O, Ogden CL, Fink S, Clark J, et al. National Health and Nutrition Examination Survey, 2017–March 2020 prepandemic file: sample design, estimation, and analytic guidelines. (Published online). *Vital Health Stat Ser 2 Data Eval Methods Res*2022. <https://doi.org/10.15620/cdc:115434>
28. CDC National Center for Health Statistics. National Health and Nutrition Examination Survey: Analytic Guidelines, 2011–2014 and 2015–2016; 2018.
29. Hill CL, Parsons J, Taylor A, Leach G. Health related quality of life in a population sample with arthritis (Published online). *J Rheumatol*1999.
30. Plotnikoff R, Karunamuni N, Lytvyak E, Penfold C, Schopflocher D, Imayama I, et al. Osteoarthritis prevalence and modifiable factors: a population study. (Published online). *BMC Public Health*2015. <https://doi.org/10.1186/s12889-015-2529-0>. (Published online).
31. Center for Health Statistics N. Healthy People 2020 Leading Health Indicators. Lead Heal Indic 2030; 2020.
32. Hales CM, Carroll MD, Fryar CD, Ogden CL. Prevalence of obesity among adults and youth: United States, 2015–2016 (Published online). *NCHS Data Brief*2017. (Published online).
33. Duca LM, Helmick CG, Barbour KE, Guglielmo D, Murphy LB, Boring MA, et al. Self-management education class attendance and health care provider counseling for physical activity among adults with arthritis — United States, 2019. (Published online). *MMWR Morb Mortal Wkly Rep*2021. <https://doi.org/10.15585/mmwr.mm7042a2>
34. Inam SHA, Riaz B, Jamil H, Rafique D, Siddiqi UA, Iqbal M, et al. Do patients with osteoarthritis get weight loss counseling. (Published online). *Cureus*2020. <https://doi.org/10.7759/cureus.11502>. (Published online).
35. Hall KD, Kahan S. Maintenance of lost weight and long-term management of obesity. (Published online). *Med Clin North Am*2018. <https://doi.org/10.1016/j.mcna.2017.08.012>. (Published online).
36. Panunzi S, Maltese S, De Gaetano A, Capristo E, Bornstein SR, Mingrone G. Comparative efficacy of different weight loss treatments on knee osteoarthritis: a network meta-analysis. (Published online). *Obes Rev*2021. <https://doi.org/10.1111/obr.13230>

37. Tubach F, Ravaud P, Martin-Mola E, Awada H, Bellamy N, Bombardier C, *et al.* Minimum clinically important improvement and patient acceptable symptom state in pain and function in rheumatoid arthritis, ankylosing spondylitis, chronic back pain, hand osteoarthritis, and hip and knee osteoarthritis: Results from a prospective multina. (Published online). *Arthritis Care Res*2012. <https://doi.org/10.1002/acr.21747>
38. Lim YZ, Wong J, Hussain SM, Estee MM, Zolio L, Page MJ, *et al.* Recommendations for weight management in osteoarthritis: a systematic review of clinical practice guidelines. (Published online). *Osteoarthr Cartil Open*2022. <https://doi.org/10.1016/j.ocarto.2022.100298>
39. Bleich SN, Pickett-Blakely O, Cooper LA. Physician practice patterns of obesity diagnosis and weight-related counseling. (Published online). *Patient Educ Couns*2011. <https://doi.org/10.1016/j.pec.2010.02.018>
40. Kristeller JL, Hoerr RA. Physician attitudes toward managing obesity: differences among six specialty groups. (Published online). *Prev Med*1997. <https://doi.org/10.1006/pmed.1997.0171>
41. Wilding JPH, Batterham RL, Calanna S, Davies M, Van Gaal LF, Lingway I, *et al.* Once-weekly semaglutide in adults with overweight or obesity. (Published online). *N Engl J Med*2021. <https://doi.org/10.1056/nejmoa2032183>