The validity of self-reported body mass index in a population-based osteoarthritis study

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Abstract

Background: Obesity is a well-known risk factor for osteoarthritis (OA). The majority of obesity research in OA is performed using self-reported BMI-data, however, its validity in persons with OA is unknown. The aim of this study was to compare the validity of self-reported body mass index (BMI) in persons with and without clinical osteoarthritis (OA) in a population-based survey.

Methods: Height and weight were self-reported, and thereafter measured in 600 persons with and without clinical OA according to the American College of Rheumatology-criteria (knees, hips and/or hands). We compared the differences between measured and self-reported heights, weights and BMIs (kg/m²) for the two groups and explored whether demographic/clinical factors were associated with inaccurate reporting in the OA patients using multivariate linear regression analyses.

Results: Mean (SD) age was 64 (8.7) years and 412 (69%) were women. Participants with clinical OA (n = 449) underreported their BMI to a greater extent than participants without clinical OA (n = 151) [mean (SD) difference 1.34 (1.68) kg/m² and 0.78 (1.40) kg/m² (p = 0.000), respectively]. There was a strong dose-dependent association between higher measured BMI and greater underreporting of BMI in multivariate analyses (BMI 25–29.99 kg/m²: B = 0.40, 95% CI, 0.06, 0.77), BMI ≥ 30 kg/m²: B = 1.30, 95% CI, 0.86, 1.75) in the clinical OA patients. A higher age as well as the time interval from self-reported to measured BMI-data were associated with inaccurate reporting.

Conclusions: Researchers using self-reported height and weight data should be aware of limited agreement with actual height and weight in overweight and obese individuals with clinical OA.

Keywords: Body mass index, Obesity, Self-report, Osteoarthritis, Age, Validity

Background

Obesity is one of very few modifiable risk factors for lower limb osteoarthritis (OA) [1,2] and may also be a risk factor for hand OA [3]. Measures of overweight and obesity are frequently based on self-reported height and weight and reported as Body Mass Index (BMI) [1,2]. However, the self-reported values may reflect people’s wishes and desires rather than reality [4], and results from studies using self-reported BMI may therefore be biased.

Using self-reported rather than measured BMI in research will save much time and costs. However, a systematic review of the validity of self-reported height and weight showed an overall trend of underestimating weight and overestimating height across a wide range of different populations [5]. The great individual variability made it impossible to pool the results and to make an accurate estimation of the actual BMI based on the self-reported BMI. The review emphasized the importance of estimating the extent of misclassification in each specific patient group. Previous studies have shown that the reliability of self-reported BMI-data may be dependent on age, sex, socioeconomic status and measured BMI category [4,6,7]. The differences in health outcomes between persons with a high and low socioeconomic status are often due to modifiable lifestyle factors or due to poor mental health [8]. Hence, lifestyle factors and health-related variables might be hypothesized to play a role for inaccurately reported BMI-data.

In OA populations, the trustworthiness of self-reported BMI and the characteristics of inaccurate reporters are

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unknown. As obesity is one of very few known modifiable risk factors for both incident and progressive OA, obesity research may have a significant impact on future prevention and disease management. Improved knowledge of the trustworthiness of self-reported BMI data in OA patients is important for the design and interpretation of future studies and may shed new light on existing studies of obesity in OA.

Hence, the aims of this study were to compare the validity of self-reported heights, weights and BMIs in persons with and without clinical OA and to study factors associated with inaccurate reporting of these data in persons with clinical OA.

Methods
This cross-sectional study is a part of the Musculoskeletal pain in Ulselfsaker study, where all persons aged 40–79 years in 2010 living in Ulselfsaker municipality were sent questionnaires regarding musculoskeletal complaints (n = 12,155 of whom 4,994 responded (41%)). Height (cm) and weight (kg) were self-reported on the questionnaire with participants being unaware of later measurement. Those who answered “Yes” to the question “Do you have osteoarthritis in the knees, hips and/or hand?” were asked to attend a clinical examination at Diakonhjemmet Hospital, Oslo, Norway. We measured height (cm) and weight (kg) with the participant wearing light indoor clothing, shoes removed and pockets emptied and screened for clinical OA in the knees, hips and hands. A detailed protocol of the study has been published elsewhere [9]. Approval for the study was granted by the Norwegian Regional Committee for Medical and Health Research Ethics (Ref. no. 2008/812a) and the Norwegian Data Inspectorate, and all participants signed informed consent.

BMI
BMI was calculated based on both self-reported and measured height and weight (kg/m²). Heights in centimetres and weight in kilograms were both measured once by different project coordinators in a standardized way. We have no data on reliability. When we refer to “self-reported BMI”, we mean calculated BMI based on self-reported height and weight. Similarly, when we refer to “measured BMI” we mean calculated BMI based on measured height and weight. Participants were divided into three BMI-categories (measured BMI) according to the World Health Organization [10]. Normal weight was defined as BMI <24.99 kg/m², overweight as BMI 25–29.99 kg/m² and obesity as BMI ≥30 kg/m².

OA variables
A rheumatologist or medical students screened for clinical OA in the knees, hips and hands according to the American College of Rheumatology (ACR) criteria [11]. Participants were tested only once and no reliability data exist. Those who fulfilled the criteria in either the knees, hips and/or hands were classified as having a clinically meaningful OA diagnosis, whereas those not fulfilling the criteria in any joint were classified as having no clinical OA.

Covariates
The time interval between the date of self-reporting BMI-data and the date of clinical examination was measured in months. Educational status was used as a measure of socioeconomic status and defined as the highest education level achieved. It was categorized into “primary/upper secondary school” versus “≥1 year at college/university”. We used the International Physical Activity Questionnaire score for measuring physical activity level (0–2 scale representing low, moderate and high levels) [12]. Smoking status was dichotomized into “never/former smoker” versus “present smoker”. The educational status and smoking covariates were dichotomized in order to improve statistical efficiency. This was not done with IPAQ as it is measured on a validated questionnaire with a standardized categorization. Mental health status was measured by the Short-Form (SF)-36 mental summary component score (0–100, higher score = better health) [13].

Statistics
The differences between self-reported and measured BMI-data were calculated. Close agreement was defined as a difference of +/- 1.00–1.99 kg/m², whereas exact agreement was defined as a difference of +/- 0.99 kg/m² or less. A difference of above +/- 2.00 kg/m² was classified as poor agreement. We examined the percentages agreement between measured and self-reported BMI within each BMI-category and compared participants with and without clinical OA using Chi-square test or Fischer’s exact test. We also examined the absolute differences in BMI, heights and weights across measured BMI-categories for participants with and without clinical OA and compared the groups using independent sample t-tests after having inspected data for normality (examining histograms). A positive difference indicates underreporting (self-reported < measured) and a negative difference indicates overreporting (self-reported > measured).

In multivariate linear regression analyses (robust standard error), we explored whether demographic and clinical factors were associated with the difference between self-reported and measured data for the participants with clinical OA taking the time interval between self-report and measurement into account. We used a descriptive modelling approach not aimed at either explanation or prediction.

P-values ≤0.05 were considered statistically significant. All analyses were performed using STATA IC13.
Results
In total, 1049 participants had self-reported OA in the knees, hips and/or hands, of whom 1019 were asked to attend the clinical examination and signed informed consent in the time interval between self-report and measurement. Of the 630 participants who attended the examination, we excluded n = 19 participants due to missing self-reported BMI-data and n = 13 participants due to missing clinical joint examination (of whom 2 also had missing BMI-data). Reasons for not being willing to attend the clinical examination are unclear. Our study sample consisted of 600 persons, of whom 449 (74.8%) had clinical OA in the knees, hips and/or hands according to the ACR-criteria, and 151 (25.2%) who did not fulfill the ACR criteria for any of the three joint locations. Participants’ characteristics are presented in Table 1.

Participants with clinical OA had less accurate self-reported BMI than participants without clinical OA (mean [SD] BMI difference 1.34 [1.68] kg/m² and 0.78 [0.40] kg/m² (p < 0.001), respectively). This was particularly evident for normalweight and obese participants (Table 2). For both participants with and without clinical OA, the percentage exact agreement was lower in those who were overweight or obese. Obese participants with clinical OA had significantly poorer agreement than obese participants without clinical OA, but no group differences in percentage agreement could be observed for normal- and overweight participants (Table 2).

When looking at height and weight separately, we also observed a strong dose-dependent association between greater overreporting of height and underreporting of weight in those who were overweight or obese (data not shown). Participants with clinical OA underreported their weights to a greater extent than participants without clinical OA (mean [SD] difference in kg, 2.48 (0.20) and 1.13 (0.31), p < 0.001, respectively). In stratified analyses by BMI-category, the significant weight difference was only evident for the normalweight and obese participants, whereas for height, no group differences could be observed in any analyses (data not shown).

A dose-dependent association between a higher BMI-category and greater underreported BMI remained in multivariate analyses (Table 3). Furthermore, a higher age was associated with greater overreporting of height and underreporting of weight (Table 3).

Discussion
This study showed a strong dose-dependent association between a higher measured BMI and greater overreporting of height and underreporting of weight and BMI both in persons with and without clinical OA. Participants with clinical OA reported their heights and weights less accurately than participants without clinical OA.

### Table 1 Participants’ characteristics

|                              | Participants With OA | Participants Without OA |
|------------------------------|----------------------|-------------------------|
|                               | n = 449              | n = 151                 |
| **Sociodemographics and covariates** |                      |                         |
| Age, mean (SD)               | 64.6 (8.6)           | 61.8 (8.9)              |
| Females, n (%)               | 321 (71.5)           | 91 (60.3)               |
| Education status, n (%)      |                      |                         |
| primary/upper secondary school | 318 (72.3)        | 98 (67.6)               |
| >1 year college/university   | 122 (27.7)           | 47 (32.4)               |
| IPAQ, low physical activity level, n (%) | 112 (33.5)    | 37 (30.8)               |
| Smoker, n (%)                | 64 (14.4)            | 21 (13.9)               |
| SF-36 mental component score [0–100], mean (SD) | 48.7 (10.9) | 47.4 (10.9) |
| Months from self-report to measurement, mean (SD) | 7.9 (4.3)  | 7.9 (4.0)   |
| **Anthropometrics**          |                      |                         |
| **Self-reported data**       |                      |                         |
| Height (cm), mean (SD)       | 169.6 (8.6)          | 171.2 (9.2)             |
| Weight (kg), mean (SD)       | 78.0 (15.7)          | 78.9 (16.1)             |
| BMI (kg/m²), mean (SD)       | 27.0 (4.5)           | 26.8 (4.2)              |
| Normalweight, n (%)          | 163 (36.3)           | 58 (38.4)               |
| Overweight, n (%)            | 189 (42.1)           | 67 (44.4)               |
| Obese, n (%)                 | 97 (21.6)            | 26 (17.2)               |
| **Measured data**            |                      |                         |
| Height (cm), mean (SD)       | 168.2 (8.6)          | 170.0 (9.3)             |
| Weight (kg), mean (SD)       | 80.4 (16.4)          | 80.0 (16.3)             |
| BMI (kg/m²), mean (SD)       | 28.3 (4.9)           | 27.6 (4.4)              |
| Normalweight, n (%)          | 126 (28.1)           | 47 (31.1)               |
| Overweight, n (%)            | 166 (37.0)           | 62 (41.1)               |
| Obese, n (%)                 | 157 (35.0)           | 42 (27.8)               |
| **OA site, n (%)**           |                      |                         |
| Single site OA               | 285 (63.5)           |                         |
| Knee OA                      | 69 (15.4)            |                         |
| Hip OA                       | 42 (9.4)             |                         |
| Hand OA                      | 174 (38.8)           |                         |
| Multisite OA                 | 164 (36.5)           |                         |
| Knees + hips                 | 21 (4.7)             |                         |
| Knees + hands                | 64 (14.3)            |                         |
| Hips + hands                 | 59 (13.1)            |                         |
| Hips + knees + hands         | 20 (4.5)             |                         |

Abbreviations: ACR American college of Rheumatology, BMI Body Mass Index, cm centimeter, IPAQ International Physical Activity Questionnaire, kg kilograms, m meter, OA osteoarthritis, SD standard deviation, SF-36 Short-Form 36.

*Participants with clinical OA according to the ACR-criteria in the knees, hips and/or hands. † Participants without clinical OA according to the ACR-criteria in any joint.
Table 2 Absolute differences and agreement between self-reported and measured BMI in participants with and without OA

|                        | Participants with clinical OA (n = 449) | Participants without clinical OA (n = 151) | P-value |
|------------------------|----------------------------------------|------------------------------------------|---------|
| Normalweight (<25 kg/m²) | 0.64 (0.93)                            | -0.00 (1.49)                             | 0.000   |
| Difference between measured and self-reported BMI, mean (SD) | 1.20 (1.60)                            | 1.05 (1.14)                             | 0.256   |
| Poor agreement, n (%)  | 3 (2.4)                                | 2 (4.3)                                  |         |
| Close agreement, n (%) | 42 (33.3)                              | 16 (34.0)                                |         |
| Exact agreement, n (%) | 81 (64.3)                              | 29 (61.7)                                | 0.754   |
| Overweight (25–29.99 kg/m²) | 2.07 (1.95)                            | 1.26 (1.31)                             | 0.006   |
| Poor agreement, n (%)  | 18 (10.8)                              | 3 (4.8)                                  |         |
| Close agreement, n (%) | 89 (53.6)                              | 35 (56.5)                                |         |
| Exact agreement, n (%) | 59 (35.5)                              | 24 (38.7)                                | 0.406   |
| Obese (≥30 kg/m²)      | 2.10 (1.95)                            | 1.26 (1.31)                             | 0.006   |
| Difference between measured and self-reported BMI, mean (SD) | 1.20 (1.60)                            | 1.05 (1.14)                             | 0.256   |
| Poor agreement, n (%)  | 18 (10.8)                              | 3 (4.8)                                  |         |
| Close agreement, n (%) | 89 (53.6)                              | 35 (56.5)                                |         |
| Exact agreement, n (%) | 59 (35.5)                              | 24 (38.7)                                | 0.406   |

Abbreviations: BMI Body Mass Index, kg kilograms, m meter, OA osteoarthritis. Poor agreement: ≥±2.00 kg/m² difference, close agreement: ≥±1.00–1.99 kg/m² difference, exact agreement: <±0–0.99 kg/m² difference. Differences are the self-reported BMI (kg/m²) minus measured BMI (kg/m²). Positive values indicate underreporting, negative values indicate overreporting.

Table 3 Explanatory factors for differences between self-report and measurement in OA patients (n = 449)

|                          | Height difference (measured minus self-report) B (95% CI) | Weight difference (measured minus self-report) B (95% CI) | BMI difference (measured minus self-report) B (95% CI) |
|--------------------------|----------------------------------------------------------|----------------------------------------------------------|-------------------------------------------------------|
| Age, mean (SD)           | -0.08 (-0.11, -0.05)                                     | -0.07 (-0.13, -0.01)                                     | 0.00 (-0.02, 0.03)                                    |
| Sex, female              | -0.17 (-0.75, 0.41)                                      | 0.23 (-0.81, 1.27)                                      | 0.33 (-0.06, 0.71)                                    |
| BMI-categorya             |                                                          |                                                          |                                                       |
| Overweight (25–29.99 kg/m²) | -0.93 (-0.97, 0.11)                                     | 0.61 (-0.35, 1.57)                                      | 0.42 (0.06, 0.77)                                     |
| Obese (≥30 kg/m²)        | -0.94 (-1.57, -0.31)                                     | 2.49 (1.34, 3.64)                                       | 1.30 (0.86, 1.75)                                     |
| Education status, >1 year college/university | -0.25 (-0.91, 0.42)                                     | 0.91 (-0.10, 1.91)                                      | 0.37 (-0.04, 0.77)                                    |
| IPAQ, low physical activity levelb |                                                          |                                                          |                                                       |
| Moderate activity        | 0.34 (0.37, 1.06)                                         | -1.18 (-2.24, -0.13)                                    | -0.54 (-0.96, -0.12)                                  |
| Vigorous activity        | -0.06 (-0.64, 0.52)                                      | -0.29 (-1.46, 0.87)                                     | -0.11 (-0.55, 0.33)                                   |
| Smoker                   | -0.44 (-1.11, 0.23)                                      | -0.16 (-1.26, 0.94)                                     | 0.10 (-0.31, 0.51)                                    |
| SF-36 mental component score [0–100] | 0.01 (-0.01, 0.04)                                      | 0.01 (-0.03, 0.05)                                      | -0.00 (-0.02, 0.01)                                   |
| Time between self-report and measurement | -0.15 (-0.23, -0.07)                                    | 0.08 (-0.03, 0.20)                                      | 0.08 (0.04, 0.12)                                     |

Abbreviations: BMI body mass index, CI confidence interval, IPAQ International Physical Activity Questionnaire, SF-36 Short-Form 36. Multivariate linear regression analyses. Estimates are unstandardized. aNormalweight is reference category bLow physical activity level is reference category. Bold prints are significantly associated with the outcome.
height but not weight. The larger misreport of height might be due to participants’ high age. Furthermore, all participants without clinical OA had self-reported OA. Participants with self-reported OA are likely to be different from persons with no self-reported OA. This might have influenced our results. However, with our approach using clinical OA criteria (including present OA pain) we were able to discriminate between participants having versus not having a clinically meaningful disease.

Conclusion
In conclusion, our study showed that persons with clinically diagnosed OA underreported their BMI to a higher extent than people with no clinical OA. Furthermore, obese persons with diagnosed clinical OA were more likely to underreport than obese persons without clinical OA. Our findings should be taken into account in future OA studies of BMI based on self-report.

Abbreviations
ACR: American college of rheumatology; BMI: Body mass index; OA: Osteoarthritis; SD: Standard deviation; SF-36: Short-form 36.

Competing interests
The authors declare that they have no competing interests.

Authors’ contributions
KM has contributed to study design, analyses and interpretation of data and has drafted the manuscript. NØ and BN have contributed to acquisition of data. IKH, LN and KBH has contributed to conception and design of the study. All authors have revised the manuscript and given approval for the final version to be published.

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References
1. Jiang L, Tian W, Wang Y, Rong J, Bao C, Liu Y, Zhao Y, Wang C. Body mass index and susceptibility to knee osteoarthritis: a systematic review and meta-analysis. Joint Bone Spine 2012, 79:291–297.
2. Jiang L, Rong J, Wang Y, Hu F, Bao C, Li X, Zhao Y. The relationship between body mass index and hip osteoarthritis: a systematic review and meta-analysis. Joint Bone Spine 2011, 78:150–153.
3. Yusuf E, Nelissen RG, Ioan-Facsinay A, Stojanovic-Susulic V, DeGroot J, VanOech G, Middelkoop S, Huzinga TW, Kloppenburg M: Association between weight or body mass index and hand osteoarthritis: a systematic review. Ann Rheum Dis 2010, 69:761–765.
4. Ziebland S, Thorogood M, Fuller A, Muij J. Desire for the body normal: body image and discrepancies between self reported and measured height and weight in a British population. J Epidemiol Community Health 1996, 50:105–106.
5. Connor GS, Tremblay M, Moher D, Gorber B: A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. Obes Rev 2007, 8:307–326.
6. Kuzczynski MF, Kuczynski RJ, Najjar M: Effects of age on validity of self-reported height, weight, and body mass index: findings from the Third National Health and Nutrition Examination Survey, 1988–1994. J Am Diet Assoc 2001, 101:28–34.
7. Bostrom G, Diderichsen F: Socioeconomic differentials in misclassification of height, weight and body mass index based on questionnaire data. Int J Epidemiol 1997, 26:860–866.
8. Nyholm M, Gulberg B, Haglund B, Rastam M, Lindblad U: Higher education and more physical activity limit the development of obesity in a Swedish rural population. The Skaraborg project. Int J Obes (Lond) 2008, 32:533–540.
9. Österle N, Risberg MA, Kven TK, Engebretsen L, Nordsetten L, Brusgaard D, Schjerheim UB, Haugen IK, Hammer HB, Provan S, Østestad BE, Semb AG, Rollefstad S, Hagen KB, Uhlig T, Ståkowsky-Christensen B, Knutsen J, Flugeud G, Grothe M, Sessem S, Edvardsen H, Natvig B: Hand, hip and knee osteoarthritis in a Norwegian population-based study - The MUST protocol. BMC Musculoskeletal Disord 2013, 14:201.
10. WHO: Physical status: the use and interpretation of anthropometry. Report of a WHO Expert Committee. World Health Organ Tech Rep Ser 1985, 553:1–452.
11. Atman RD: Criteria for classification of clinical osteoarthritis. J Rheumatol Suppl 1991, 27:10–12.
12. Craig CL, Marshall AL, Sjostrom M, Bauman AE, Booth ML, Ainsworth BE, Pratt M, Ekelund U, Yngve A, Sallis JF, Oja P: International physical activity questionnaire: 12-country reliability and validity. Med Sci Sports Exerc 2003, 35:1361–1375.
13. Ware JE Jr, Sherbourne CD: The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Med Care 1992, 30:473–483.
14. Bagjevac M, Jinks C, Jefferies A, Jordan KP: Risk factors for onset of osteoarthritis of the knee in older adults: a systematic review and meta-analysis. Osteoarthr Cartil 2010, 18:24–33.

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