Impact of competing mortality risks on predictive performance of the QFracture risk prediction tool for major osteoporotic fracture and hip fracture: external validation cohort study in a UK primary care population

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Table S1: Read codes defining major osteoporotic fracture including hip fracture

| Fracture type       | CPRD Medcode | Read Code | Read Code description                                      |
|---------------------|--------------|-----------|-----------------------------------------------------------|
| Hip                 | 2225         | S30..00   | Fracture of neck of femur                                  |
| Hip                 | 1994         | S30..11   | Hip fracture                                              |
| Hip                 | 38489        | S300.00   | Closed fracture proximal femur, transcervical              |
| Hip                 | 39984        | S300000   | Cls # prox femur, intracapsular section, unspecified       |
| Hip                 | 69919        | S300100   | Closed fracture proximal femur, transepiphyseal            |
| Hip                 | 65690        | S300200   | Closed fracture proximal femur, midcervical section        |
| Hip                 | 52194        | S300300   | Closed fracture proximal femur, basicervical               |
| Hip                 | 51861        | S300311   | Closed fracture, base of neck of femur                     |
| Hip                 | 36391        | S300400   | Closed fracture head of femur                              |
| Hip                 | 17019        | S300500   | Cls # prox femur, subcapital, Garden grade unspec.         |
| Hip                 | 34351        | S300600   | Closed fracture proximal femur, subcapital, Garden grade I |
| Hip                 | 33957        | S300700   | Closed fracture proximal femur, subcapital, Garden grade II|
| Hip                 | 36599        | S300800   | Closed fracture proximal femur, subcapital, Garden grade III|
| Hip                 | 34078        | S300900   | Closed fracture proximal femur, subcapital, Garden grade IV|
| Hip                 | 49209        | S300y00   | Closed fracture proximal femur, other transcervical        |
| Hip                 | 68229        | S300y11   | Closed fracture of femur, subcapital                       |
| Hip                 | 62966        | S300z00   | Closed fracture proximal femur, transcervical, NOS         |
| Hip                 | 5301         | S302.00   | Closed fracture of proximal femur, pertrochanteric         |
| Hip                 | 19117        | S302000   | Closed fracture of femur, greater trochanter               |
| Hip                 | 19337        | S302012   | Closed fracture of femur, lesser trochanter                |
| Hip                 | 45141        | S302100   | Closed fracture proximal femur, intertrochanteric, two part|
| Hip                 | 29145        | S302200   | Closed fracture proximal femur, subtrochanteric            |
| Hip                 | 51216        | S302300   | Cls # proximal femur, intertrochanteric, comminuted        |
| Hip                 | 8648         | S302400   | Closed fracture of femur, intertrochanteric                |
| Hip                 | 44735        | S302z00   | Cls # of proximal femur, pertrochanteric section, NOS      |
| Hip                 | 28965        | S304.00   | Pertrochanteric fracture                                   |
| Hip                 | 8243         | S305.00   | Subtrochanteric fracture                                   |
| Hip                 | 24276        | S30w.00   | Closed fracture of unspecified proximal femur              |
| Hip                 | 18273        | S30y.00   | Closed fracture of neck of femur NOS                       |
| Hip                 | 10570        | S30y.11   | Hip fracture NOS                                          |
| Hip                 | 37662        | S310000   | Closed fracture of femur, unspecified part                  |
| Distal radius/ulna  | 520          | S31z.00   | Fracture of femur, NOS                                     |
| Distal radius/ulna  | 5951         | 7K1LM00   | Closed reduction of fracture of wrist                      |
| Distal radius/ulna  | 18299        | S234.00   | Closed fracture of radius and ulna, lower end              |
| Distal radius/ulna  | 203          | S234.11   | Wrist fracture - closed                                    |
| Distal radius/ulna  | 18389        | S234000   | Closed fracture of forearm, lower end, unspecified         |
| Distal radius/ulna  | 343          | S234100   | Closed Colles’ fracture                                    |
| Distal radius/ulna  | 52389        | S234111   | Smith’s fracture - closed                                  |
| Distal radius/ulna  | 1742         | S234200   | Closed fracture of the distal radius, unspecified          |
| Distal radius/ulna  | 28708        | S234600   | Closed fracture radius and ulna, distal                    |
| Distal radius/ulna  | 2862         | S234700   | Closed Smith’s fracture                                    |
| Condition                                      | Code   | Description                                      |
|------------------------------------------------|--------|--------------------------------------------------|
| Closed Galeazzi fracture                        | S234800| Distal radius/ulna                               |
| Closed volar Barton’s fracture                  | S234900| Distal radius/ulna                               |
| Closed volar Barton’s fracture-dislocation      | S234911| Distal radius/ulna                               |
| Closed volar Barton fracture-subluxation        | S234912| Distal radius/ulna                               |
| Closed dorsal Barton’s fracture                 | S234A00| Distal radius/ulna                               |
| Closed volar Barton fracture-dislocation        | S234A11| Distal radius/ulna                               |
| Closed volar Barton fracture-subluxation        | S234A12| Distal radius/ulna                               |
| Closed fracture distal radius, intra-articular, die-punch | S234C00| Distal radius/ulna                               |
| Closed fracture distal radius, extra-articular, other type | S234D00| Distal radius/ulna                               |
| Closed fracture distal radius, extra-articular, other type | S234E00| Distal radius/ulna                               |
| Closed Barton’s fracture                        | S234G00| Distal radius/ulna                               |
| Greenstick fracture of distal radius            | S234H00| Distal radius/ulna                               |
| Closed fracture of forearm, lower end, NOS      | S234I00| Distal radius/ulna                               |
| Fracture of lower end of radius                 | S234J00| Distal radius/ulna                               |
| Fracture of lower end of both ulna and radius   | S234K00| Distal radius/ulna                               |
| Closed fracture of forearm, unspecified         | S234L00| Distal radius/ulna                               |
| Closed fracture of radius (alone), unspecified  | S234M00| Distal radius/ulna                               |
| Fracture of radius NOS                          | S234N00| Distal radius/ulna                               |
| Closed fracture-dislocation distal radio-ulnar joint | S234P00| Distal radius/ulna                               |
| Closed fracture-dislocation radiocarpal joint   | S234Q00| Distal radius/ulna                               |
| Closed fracture-subsolution, distal radio-ulnar joint | S234R00| Distal radius/ulna                               |
| Closed fracture-subsolution radiocarpal joint   | S234S00| Distal radius/ulna                               |
| Closed reduction of fracture of humerus         | S234T00| Distal radius/ulna                               |
| Fracture of humerus                             | S234U00| Distal radius/ulna                               |
| Closed fracture of the proximal humerus         | S234V00| Distal radius/ulna                               |
| Closed fracture of proximal humerus, unspecified part | S234W00| Distal radius/ulna                               |
| Closed fracture proximal humerus, neck          | S234X00| Distal radius/ulna                               |
| Closed fracture proximal humerus, anatomical neck | S234Y00| Distal radius/ulna                               |
| Closed fracture proximal humerus, greater tuberosity | S234Z00| Distal radius/ulna                               |
| Closed fracture proximal humerus, head          | S235000| Distal radius/ulna                               |
| Closed fracture of humerus, upper epiphysis     | S235500| Distal radius/ulna                               |
| Closed fracture proximal humerus, three part    | S235600| Distal radius/ulna                               |
| Closed fracture proximal humerus, four part     | S235700| Distal radius/ulna                               |
| Closed fracture of proximal humerus not otherwise specified | S235800| Distal radius/ulna                               |
| Closed fracture of humerus NOS                  | S235900| Distal radius/ulna                               |
| Fracture of upper end of humerus                | S236000| Distal radius/ulna                               |
| Fracture of humerus NOS                         | S236100| Distal radius/ulna                               |
| Fatigue fracture of vertebra                    | S236200| Distal radius/ulna                               |
| Osteoporotic vertebral collapse                 | S236300| Distal radius/ulna                               |
| Collapse of thoracic vertebra                   | S236400| Distal radius/ulna                               |
| Osteoporosis + pathological fracture lumbar vertebrae | S236500| Distal radius/ulna                               |
| Osteoporosis + pathological fracture thoracic vertebrae | S236600| Distal radius/ulna                               |
| Osteoporosis + pathological fracture cervical vertebrae | S236700| Distal radius/ulna                               |
| Collapse of thoracic vertebra                   | S236800| Distal radius/ulna                               |
| Collapse of cervical vertebra due to osteoporosis | S236900| Distal radius/ulna                               |
| Collapse of lumbar vertebra due to osteoporosis | S237000| Distal radius/ulna                               |
| Vertebral | Code      | Description                                      |
|-----------|-----------|--------------------------------------------------|
| 19048     | N331K00   | Collapse of thoracic vertebra due to osteoporosis|
| 4013      | N331L00   | Collapse of vertebra due to osteoporosis NOS     |
| 53337     | S100H00   | Closed fracture cervical vertebra, wedge         |
| 27404     | S102.00   | Closed fracture thoracic vertebra                |
| 28524     | S102100   | Closed fracture thoracic vertebra, wedge         |
| 8266      | S104100   | Closed fracture lumbar vertebra, wedge           |
| 5381      | S15..00   | Fracture of thoracic vertebra                    |
Table S2: ICD-10 codes defining major osteoporotic fractures causing hospital admission

| Fracture type       | ICD10-code | ICD-10 Code description                                      |
|---------------------|------------|--------------------------------------------------------------|
| Hip                 | S72.0      | Fracture of neck of femur                                   |
| Hip                 | S72.1      | Pertrochanteric fracture                                     |
| Hip                 | S72.2      | Subtrochanteric fracture                                     |
| Distal radius/ulna  | S52.5      | Fracture of lower end of radius                              |
| Distal radius/ulna  | S52.6      | Fracture of lower end of both ulna and radius                |
| Proximal humerus    | S42.2      | Fracture of upper end of humerus                             |
| Vertebral           | M48.5      | Collapsed vertebra, not elsewhere classified                 |
| Osteoporotic        | M80.0      | Postmenopausal osteoporosis with pathological fracture        |
| Osteoporotic        | M80.1      | Postoophorectomy osteoporosis with pathological fracture     |
| Osteoporotic        | M80.3      | Postsurgical malabsorption osteoporosis with pathological fracture |
| Osteoporotic        | M80.5      | Idiopathic osteoporosis with pathological fracture           |
| Osteoporotic        | M80.8      | Other osteoporosis with pathological fracture                |
| Osteoporotic        | M80.9      | Unspecified osteoporosis with pathological fracture          |
Table S3: Definitions of morbidity predictors for QFracture algorithm

| Morbidity                                      | How defined                                                                 |
|------------------------------------------------|------------------------------------------------------------------------------|
| Type 1 and type 2 diabetes                     | As defined for GP data in Kuan et al (2019)¹                                  |
| Parental history of osteoporosis/hip fracture   | Bespoke codeset (table SX)                                                   |
| Care home resident                             | Bespoke codeset (table SX)                                                   |
| Previous fracture                              | As per fracture outcomes (table SX) plus bespoke codeset for 'history of' codes (table SX) |
| History of falls                               | Bespoke codeset (table SX)                                                   |
| Dementia                                       | As defined for GP data in Kuan et al (2019)¹                                  |
| Cancer                                         | As defined for GP data in Kuan et al (2019)¹                                  |
| Asthma or COPD                                 | As defined for GP data in Kuan et al (2019)¹                                  |
| Heart attack, angina, stroke or TIA            | CVD outcomes in GP data defined in supplementary file at Livingstone et al (2021)² |
| Chronic liver disease                          | As defined for GP data in Kuan et al (2019)¹                                  |
| Chronic kidney disease                         | As defined for GP data in Kuan et al (2019)¹                                  |
| Parkinson’s Disease                            | As defined for GP data in Kuan et al (2019)¹                                  |
| Rheumatoid arthritis or SLE                    | As defined in GP data in Kuan et al (2019)¹                                  |
| Malabsorption²                                 | Crohn’s Disease, ulcerative colitis and coeliac disease as defined for GP data in Kuan et al (2019)²; malabsorption, steatorrhoea or blind loop syndrome bespoke codeset (table SX) |
| Endocrine problems²                            | Hyperparathyroidism as defined for GP data in Kuan et al (2019)²; thyrotoxicosis and Cushing syndrome bespoke codeset (table SX) |
| Epilepsy                                       | As defined for GP data in Kuan et al (2019)¹                                  |

¹ Crohn’s disease, ulcerative colitis, coeliac disease, steatorrhoea or blind loop syndrome
² Thyrotoxicosis, hyperparathyroidism, Cushing syndrome
Table S4: Read codes defining morbidity predictors (codesets created for this study)

| Morbidity                                                                 | CPRD Medcode | Read Code | Read Code description                          |
|---------------------------------------------------------------------------|--------------|-----------|-----------------------------------------------|
| Parental history of osteoporosis or hip fracture                          | 11218        | 1268.00   | FH: Osteoporosis                               |
| Family history of osteoporosis or hip fracture                            | 51427        | 1216.00   | FH: Fragility fracture                         |
| Family history of osteoporosis or hip fracture                            | 37204        | 1214.00   | FH: Maternal hip fracture                      |
| Family history of osteoporosis or hip fracture                            | 42319        | 1215.00   | FH: Hip fracture in first degree relative      |
| Family history of osteoporosis or hip fracture                            | 43219        | 1218.00   | FH: maternal hip fracture before age 75       |
| Care home resident                                                        | 13359        | 13F6100   | Lives in a nursing home                        |
| Care home resident                                                        | 7653         | 9N1G.00   | Seen in nursing home                           |
| Care home resident                                                        | 24956        | 13FK.00   | Lives in a residential home                    |
| Care home resident                                                        | 13360        | 13F6.00   | Nursing/other home                             |
| Care home resident                                                        | 49681        | 13FX.00   | Lives in care home                             |
| Care home resident                                                        | 27968        | 13F7.00   | Residential institution                        |
| Care home resident                                                        | 13361        | 13F4.11   | Lives in warden controlled accommodation      |
| Care home resident                                                        | 30807        | 13F4000   | Resident in sheltered accommodation            |
| Care home resident                                                        | 98592        | 8Ce4.00   | Preferred place of care - nursing home         |
| Care home resident                                                        | 6859         | 9N1F.00   | Seen in warden sup home                        |
| Care home resident                                                        | 93998        | 9b0i.00   | Residential home visit note                    |
| Care home resident                                                        | 10993        | 2LG4.00   | Discharge to nursing home                      |
| Care home resident                                                        | 101003       | 9NF.00    | Home visit request by residential institution  |
| Care home resident                                                        | 28773        | 2V60700   | [V]Sheltered housing                           |
| Care home resident                                                        | 100080       | 8Ce5.00   | Preferred place of care - residential home     |
| Care home resident                                                        | 7101         | 9N1F.12   | Seen in old people's home                      |
| Care home resident                                                        | 59653        | 6991.00   | Geriatric home admission exam.                |
| Care home resident                                                        | 73321        | 9b1P.00   | Nursing home                                  |
| Care home resident                                                        | 102493       | 8Ht..00   | Admission to nursing home                      |
| Care home resident                                                        | 107443       | 9NFW000   | Care home visit for initial patient assessment |
| Care home resident                                                        | 35187        | 9N1D.00   | Seen in warden sup house                       |
| Care home resident                                                        | 35172        | 9N1E.00   | Seen in warden sup flat                        |
| Care home resident                                                        | 34794        | 13F9.11   | Living in sheltered accomodatn                 |
| Care home resident                                                        | 21280        | 13F5200   | Resident in part III accomodation              |
| Care home resident                                                        | 107602       | 9NFW100   | Care home visit for follow-up patient review   |
| Care home resident                                                        | 42191        | 2LG3.00   | Discharge to residential home                  |
| Care home resident                                                        | 24828        | Z177F00   | Nursing home care                             |
| Care home resident                                                        | 73083        | 9b0Y.00   | Nursing home visit note                        |
| Care home resident                                                        | 94070        | 8O24.00   | Provision of continuing care in nursing home   |
| Care home resident                                                        | 107757       | 9NFW.00   | Care home visit                               |
| Care home resident                                                        | 59548        | 13FT.00   | Lives in an old peoples home                  |
| Care home resident                                                        | 102598       | 8Hs..00   | Discharge to nursing home                      |
| Care home resident                                                        | 27936        | 8HE6.00   | Delayed discharge to nursing home              |
| Care home resident                                                        | 24816        | Z177C00   | Residential care                               |
| Care home resident                                                        | 50792        | 9N1F.11   | Seen in Part 3 accomodation                    |
| Care home resident | 36096 | 13F5.11 | Part 3 accommodation |
|--------------------|-------|---------|----------------------|
| Care home resident | 6991  | 9493.00 | Patient died in nursing home |
| Care home resident | 43915 | ZLG4100 | Discharge to private nursing home |
| Care home resident | 49138 | ZV63212 | [V]Delayed discharge - nursing home vacancy awaited |
| Care home resident | 27360 | 13F5100 | Part III accommodation arranged |
| Care home resident | 98758 | 1326.00 | Previously lived in care home |
| Care home resident | 36905 | ZLG5100 | Discharge to wardens controlled accommodation |
| Care home resident | 49138 | ZV63212 | [V]Delayed discharge - nursing home vacancy awaited |
| Care home resident | 27360 | 13F5100 | Part III accommodation arranged |
| Care home resident | 36905 | ZLG5100 | Discharge to wardens controlled accommodation |
| Care home resident | 35040 | ZLG5.00 | Discharge to sheltered housing |
| Care home resident | 102230 | M270100 | Nursing home acquired pressure ulcer |
| Care home resident | 48549 | ZLG3100 | Discharge to private residential home |
| Care home resident | 95795 | 9230.00 | FP22 - removal from residential institute |
| Care home resident | 67903 | U105100 | [X]Fall involving wheelchair occurrence residential insti‘n |
| Care home resident | 67903 | U105100 | [X]Fall involving wheelchair occurrence residential insti‘n |
| Care home resident | 99148 | 9b79.00 | Other residential care homes managed by local authority |
| Care home resident | 66122 | 13F5111 | Part 3 accommodation arranged |
| Care home resident | 99148 | 9b7A.00 | Other residential care home man voluntary/private agents |
| Care home resident | 96836 | ZK76.00 | Temporary home care service provision |
| History of fracture* | 17936 | 14G7.00 | H/O: hip fracture |
| History of fracture* | 18731 | 14G6.00 | H/O: fragility fracture |
| History of fracture* | 19235 | 14G8.00 | H/O: vertebral fracture |
| History of falls | 384 | TC...11 | Fall - accidental |
| History of falls | 6815 | TC...00 | Accidental falls |
| History of falls | 6008 | 16D..00 | Falls |
| History of falls | 4859 | R200.12 | [D] Geriatric fall |
| History of falls | 6835 | TCz..00 | Accidental falls NOS |
| History of falls | 8694 | 16D1.00 | Recurrent falls |
| History of falls | 8730 | TCy..00 | Other falls |
| History of falls | 15112 | TC5...00 | Fall on same level from slipping, tripping or stumbling |
| History of falls | 11307 | TC0...00 | Fall on or from stairs or steps |
| History of falls | 11308 | TCy...00 | Other accidental fall NOS |
| History of falls | 17167 | TC01.00 | Fall on or from stairs |
| History of falls | 11709 | TCS1.00 | Fall on same level from tripping |
| History of falls | 33887 | TC4..00 | Other fall from one level to another |
| History of falls | 17728 | TC01000 | Fall on stairs |
| History of falls | 108062 | 16D6.00 | Fall |
| History of falls | 18007 | TC50.00 | Fall on same level from slipping |
| History of falls | 21081 | TC01100 | Fall from stairs |
| History of falls | 26432 | TC42100 | Fall from bed |
| History of falls | 7948 | TC52.00 | Fall on same level from stumbling |
| History of falls | 33529 | TC5z.00 | Fall on same level from slipping |
| History of falls | 98223 | 16D5.00 | Fall onto outstretched hand |
| History of falls | 41909 | TC01z00 | Fall on or from stairs NOS |
| History of falls | 43092 | TC02000 | Fall on steps |
| History of falls | 43571 | TC3...00 | Fall into hole or other opening in surface |
| History of falls | 21306 | TC4z.00 | Fall from one level to another NOS |
| History of falls | Code | Description |
|-----------------|------|-------------|
| 53082           | TCO2100 | Fall from steps |
| 44626           | TC02.00 | Fall on or from steps |
| 38818           | TC42000 | Fall from chair |
| 64696           | TC0z.00 | Fall on or from stairs or steps NOS |
| 7876            | TC4yz00 | Other fall from one level to another NOS |
| 41853           | TC4y.00 | Other fall from one level to another |
| 69020           | TC4y200 | Fall from stationary vehicle |
| 93574           | 8O9..00 | Provision of telecare community alarm service |
| 53463           | TC00.00 | Fall on or from escalator |
| 56316           | TC00000 | Fall on escalator |
| 64722           | TC02z00 | Fall on or from steps NOS |
| 59404           | TC42.00 | Fall from chair or bed |
| 29568           | TC3yz00 | Fall into other hole |
| 55743           | 67ID.00 | Falls advice - hip protectors advised |
| 48309           | 67IE.00 | Falls advice - hip protectors supplied |
| 44119           | 8BIG.00 | Falls caused by medication |
| 109088          | 9Nlf.00 | Seen by community falls team |
| 16684           | T04..00 | Fall in |
| 58753           | T040.00 | Fall in train |
| 94933           | T040100 | Fall in train |
| 59911           | T041.00 | Fall on train |
| 97335           | T04z.00 | Fall in |
| 18097           | T170.00 | MVTA - fall down stairs of motor bus while board/alighting |
| 41114           | T171.00 | MVTA - fall from car in street while boarding/alighting |
| 60782           | T53..00 | Fall in |
| 110413          | T53z.00 | Fall in |
| 60003           | TC42z00 | Fall from chair or bed NOS |
| 17638           | TH03.00 | Late effects of accidental fall |
| 7970            | U10..00 | [X]Falls |
| 21903           | U100.00 | [X]Fall on same level involving ice and snow |
| 68559           | U100000 | [X]Fall on same level involving ice and snow occurrn home |
| 63515           | U100200 | [X]Fall same lvl inv ice/snw occ sch oth inst/pub admin area |
| 43615           | U100300 | [X]Fall same level involv ice/snow |
| 60427           | U100400 | [X]Fall same level inv ice and snow |
| 93148           | U100500 | [X]Fall same level inv ice / snow |
| 71613           | U100z00 | [X]Fall same lev inv ice / snow |
| 29821           | U101.00 | [X]Fall on same level from slipping |
| 49035           | U101000 | [X]Fall same level frm slip trip + stumb |
| 49210           | U101100 | [X]Fall same level from slip trip + stumb occ resid instit |
| 60424           | U101200 | [X]Fall sme lev slip trp+stmb occ sch |
| 49100           | U101300 | [X]Fall sme lev frm slip trip+stumb |
| 52452           | U101400 | [X]Fall same level from slip trip+stumb |
| 68616           | U101500 | [X]Fall sme lvl frm slip trip+stumb |
| 68895           | U101600 | [X]Fall same level |
| History of falls          | U1 | Code       | Description                                                   |
|--------------------------|----|------------|--------------------------------------------------------------|
| 61705                    |    | U101700    | [X]Fall same level from slip trip+stumbling                  |
| 49218                    |    | U101y00    | [X]Fall same level                                           |
| 68579                    |    | U101z00    | [X]Fall same lev fm slip trip+stumbling                      |
| 111606                   |    | U102200    | [X]Fall                                                      |
| 66934                    |    | U103000    | [X]Oth fall same levl                                        |
| 109428                   |    | U103500    | [X]Oth fall sme levl coll/push anth pers occ trad/serv area  |
| 62109                    |    | U103y00    | [X]Oth fall sme levl coll/push anoth per occ oth spec place |
| 93454                    |    | U103z00    | [X]Oth fall same levl coll/push anoth pers occ unspec place |
| 67230                    |    | U104.00    | [X]Fall while being carried or supported by other persons    |
| 52410                    |    | U104000    | [X]Fall while carried/supported by other persons             |
| 51851                    |    | U104100    | [X]Fall while carried/supported by oth pers occ resid instit |
| 110968                   |    | U104z00    | [X]Fall while carr’d/supportd by oth per                     |
| 21349                    |    | U105.00    | [X]Fall involving wheelchair                                 |
| 98315                    |    | U105000    | [X]Fall involving wheelchair                                 |
| 67903                    |    | U105100    | [X]Fall involvng wheelchair occurrence residential instit'n  |
| 85959                    |    | U105500    | [X]Fall involvng wheelchair occurrence at trade/service area |
| 98713                    |    | U105700    | [X]Fall involving wheelchair                                 |
| 109423                   |    | U105y00    | [X]Fall involv wheelchiar                                     |
| 52374                    |    | U106.00    | [X]Fall involving bed                                       |
| 44419                    |    | U106000    | [X]Fall involving bed                                       |
| 69762                    |    | U106100    | [X]Fall involving bed occurrence in residential institution  |
| 50572                    |    | U107.00    | [X]Fall involving chair                                      |
| 68600                    |    | U107000    | [X]Fall involving chair                                      |
| 68617                    |    | U107z00    | [X]Fall involving chair                                      |
| 55553                    |    | U108.00    | [X]Fall involving other furniture                            |
| 68591                    |    | U108000    | [X]Fall involving other furniture                            |
| 66922                    |    | U108100    | [X]Fall involv other furniture occurrr resident institut'n   |
| 36402                    |    | U10A.00    | [X]Fall on and from stairs and steps                         |
| 52432                    |    | U10A000    | [X]Fall on and from stairs and steps                         |
| 52466                    |    | U10A100    | [X]Fall on + from stair + step occursce resident instit'n    |
| 111571                   |    | U10A200    | [X]Fall on + frm stair + step occ sch oth inst/pub adm area  |
| 99385                    |    | U10A400    | [X]Fall on + from stairs + steps occurrr on street/highway   |
| 51284                    |    | U10A500    | [X]Fall on + from stair + step occurrr at trade/service area |
| 41105                    |    | U10A511    | [X]Fall on or from escalator                                 |
| 68613                    |    | U10Ay00    | [X]Fall on + from stair + step occurrr at oth specif place   |
| 64193                    |    | U10Az00    | [X]Fall on + from stair + step occurrr at unspecif place     |
| 50316                    |    | U10D.00    | [X]Fall from                                                  |
| 52380                    |    | U10D000    | [X]Fall from out of/through building/structur occurrn home   |
| 100710                   |    | U10D100    | [X]Fall from out of/thro building/struct occ resid instit'n  |
| History of falls | 110898 | U10D400 | [X] Fall from out/thro building/struct occ on street/highway |
| History of falls | 92721  | U10H.00 | [X] Other fall from one level to another |
| History of falls | 51669  | U10H000 | [X] Other fall from one level to another |
| History of falls | 68609  | U10H200 | [X] Other fall from one level to another |
| History of falls | 68562  | U10H400 | [X] Other fall from one level to another |
| History of falls | 68604  | U10H500 | [X] Other fall from one level to another |
| History of falls | 95961  | U10H600 | [X] Other fall from one level to another |
| History of falls | 72468  | U10Hy00 | [X] Other fall from one level to another |
| History of falls | 68608  | U10H600 | [X] Other fall from one level to another |
| History of falls | 101254 | U10I400 | [X] Other fall from one level to another |
| History of falls | 68608  | U10I600 | [X] Other fall from one level to another |
| History of falls | 101523 | U10Iy00 | [X] Other fall from one level to another |
| History of falls | 98876  | U10i200 | [X] Other fall from one level to another |
| History of falls | 24776  | U10z.00 | [X] Unspecified fall |
| History of falls | 10419  | U10zo00 | [X] Unspecified fall |
| History of falls | 46303  | U10z100 | [X] Unspecified fall |
| History of falls | 55202  | U10z300 | [X] Unspecified fall |
| History of falls | 97327  | U10z400 | [X] Unspecified fall |
| History of falls | 106900 | U10z700 | [X] Unspecified fall |
| History of falls | 96546  | U10zy00 | [X] Unspecified fall |
| History of falls | 61170  | U10zz00 | [X] Unspecified fall |
| History of falls | 6785   | ZV71B00 | [V] Examination and observation following a fall |
| Malabsorption\(^b\) | 9355   | J69...00 | Intestinal malabsorption |
| Malabsorption\(^b\) | 5088   | J69y200 | Other gastrointestinal tract malabsorption NOS |
| Malabsorption\(^b\) | 4787   | J690.15 | Steatorrhea - idiopathic |
| Malabsorption\(^b\) | 6663   | J69y.00 | Other intestinal malabsorption |
| Malabsorption\(^b\) | 42715  | J69r.00 | Intestinal malabsorption NOS |
| Malabsorption\(^b\) | 23498  | J692.00 | Blind loop syndrome |
| Malabsorption\(^b\) | 31392  | J69y600 | Intestinal malabsorption of fat |
| Malabsorption\(^b\) | 2482   | D011100 | Vit B12 defic anaemia due to malabsorption with proteinuria |
| Malabsorption\(^b\) | 19441  | C285.00 | Adult osteomalacia due to malabsorption |
| Malabsorption\(^b\) | 37440  | J693.11 | Post-surgical malabsorption - other |
| Malabsorption\(^b\) | 49191  | J69y200 | Intestinal malabsorption of protein |
| Malabsorption\(^b\) | 55481  | D012300 | Folate-deficiency anaemia due to malabsorption |
| Malabsorption\(^b\) | 72529  | Jyu9000 | [X] Other intestinal malabsorption |
| Malabsorption\(^b\) | 57647  | J693100 | Post gastrointestinal tract surgery malnutrition |
| Malabsorption\(^b\) | 49739  | J69y300 | Intestinal malabsorption of carbohydrate |
| Condition                                      | Code 1 | Code 2     | Description                                      |
|-----------------------------------------------|--------|------------|--------------------------------------------------|
| Malabsorptionb                               | 93655  | N330700    | Postsurgical malabsorption osteoporosis          |
| Endocrine problems                          | 1472   | C02..11    | Hyperthyroidism                                  |
| Endocrine problems                          | 5257   | C020.12    | Graves' disease                                  |
| Endocrine problems                          | 6245   | 1431.00    | H/O: hyperthyroidism                             |
| Endocrine problems                          | 3857   | C052.11    | Autoimmune thyroiditis                           |
| Endocrine problems                          | 17604  | C150.00    | Cushing’s syndrome                               |
| Endocrine problems                          | 11947  | L181500    | Postpartum thyroiditis                           |
| Endocrine problems                          | 30799  | C051.00    | Subacute thyroiditis                             |
| Endocrine problems                          | 4898   | C050.00    | Acute thyroiditis                                |
| Endocrine problems                          | 18382  | C150111    | Drug-induced Cushing's syndrome                  |
| Endocrine problems                          | 26362  | 212P.00    | Hyperthyroidism resolved                         |
| Endocrine problems                          | 106640 | C025.00    | Subclinical hyperthyroidism                      |
| Endocrine problems                          | 21747  | C051.11    | De Quervain’s thyroiditis                        |
| Endocrine problems                          | 20275  | C150100    | Iatrogenic Cushing's syndrome                     |
| Endocrine problems                          | 60534  | C150200    | Cushing’s syndrome NOS                           |
| Endocrine problems                          | 49508  | C024.00    | Thyrotoxicosis from ectopic thyroid nodule       |
| Endocrine problems                          | 68626  | FyuBO00    | [X]Dysthyroid exophthalmos                      |
| Endocrine problems                          | 42323  | C050z00    | Acute thyroiditis NOS                            |
| Endocrine problems                          | 53682  | C150200    | Pituitary dependent Cushing’s syndrome           |
| Endocrine problems                          | 65444  | C05y.00    | Other and unspecified chronic thyroiditis       |
| Endocrine problems                          | 61026  | C054.00    | Iatrogenic thyroiditis                           |
| Endocrine problems                          | 53667  | C053.11    | Riedel’s thyroiditis                             |
| Endocrine problems                          | 65907  | C05y400    | Chronic thyroiditis with transient thyrotoxicosis|
| Endocrine problems                          | 65754  | C150500    | Alcohol-induced pseudo-Cushing’s syndrome        |
| Endocrine problems                          | 67972  | C050000    | Acute nonsuppurative thyroiditis                 |
| Endocrine problems                          | 65120  | C150300    | Ectopic ACTH secretion causing Cushing’s syndrome|
| Endocrine problems                          | 60690  | F395100    | Myopathy due to Cushing’s syndrome               |
| Endocrine problems                          | 70967  | C150000    | Idiopathic Cushing’s syndrome                    |
| Endocrine problems                          | 56270  | C024z00    | Thyrotoxicosis from ectopic thyroid nodule NOS   |
| Endocrine problems                          | 70773  | C050100    | Acute suppurative thyroiditis                    |
| Endocrine problems                          | 95807  | Cyu4500    | [X]Other Cushing's syndrome                      |
| Endocrine problems                          | 64656  | C024000    | Thyrotoxicosis from ectopic thyroid nodule with no crisis |

a. Used along with fracture outcomes to define baseline history of fracture
b. Malabsorption includes Crohn's Disease, ulcerative colitis and coeliac disease as defined by Kuan et al1 – these codes are for malabsorption, steatorrhoea or blind loop syndrome
c. Endocrine problems includes hyperparathyroidism as defined by Kuan et al (2019)1 – these codes are for thyrotoxicosis and Cushing syndrome
Table S5: CPRD Procodes defining prescribing variables (corticosteroids are only oral or injectable preparations)

| QFracture variable | CPRD drugsubstance (drug name as recorded in CPRD) | CPRD Procodes |
|--------------------|--------------------------------------------------|----------------|
| Antidepressants    | Amitriptyline hydrochloride                      | 34916, 45242, 83, 33090, 52867, 24141, 57972, 55491, 70991, 61835, 76839, 45233, 34731, 66578, 80135, 57107, 65879, 24152, 59161, 34401, 46801, 64000, 79826, 70300, 76298, 68618, 76927, 487, 34197, 41729, 42394, 34474, 32439, 49, 34782, 54877, 24145, 55139, 42078, 71042, 65987, 64647, 79766, 34503, 24134, 66579, 60355, 77167, 65439, 66572, 24147, 34129, 6312, 78364, 67127, 34224, 60410, 4682, 40396, 1888, 34274, 34634, 64330, 78221, 46970, 34182, 69712, 33624, 34107, 4690, 34251, 59820, 64141, 76952, 77497, 26213, 20026, 27008, 24680, 2486, 2985, 8726, 7751, 8332, 19779, 182, 22070, 3777, 2525, 48065, 8878, 8831 |
| Antidepressants    | Amitriptyline hydrochloride/Chlordiazepoxide     | 21081, 18342, 11963, 14534 |
| Amoxapine          |                                                   | 3652, 4411, 17319, 3351, 21357, 24723, 15380, 14398, 55289 |
| Antidepressants    | Butriptyline hydrochloride                       | 12227, 32457, 18932 |
| Antidepressants    | Clomipramine                                     | 3195 |
| Antidepressants    | Clomipramine hydrochloride                       | 30375, 26513, 7515, 3657, 8719, 7693, 7894, 3194, 34866, 68665, 41628, 62620, 43561, 3670, 34245, 41563, 45350, 65762, 8720, 64458, 3925, 45318, 41597, 53187, 78324, 65804, 53161, 38274, 78057, 8661 |
| Antidepressants    | Desipramine                                      | 7981, 7979 |
| Antidepressants    | Dosulepin hydrochloride                          | 43024, 77130, 70838, 84, 23426, 34745, 34643, 31824, 44853, 29875, 33164, 34641, 76317, 34223, 50722, 71023, 70593, 74, 32121, 19186, 67728, 42734, 31826, 34525, 62681, 71059, 34058, 57926, 1940, 15632, 21820, 21819, 67990, 51758, 1169, 2320, 30376, 21157, 19168, 45737, 6054, 10948 |
| Antidepressants    | Doxepin hydrochloride                            | 5190, 9558, 15975, 3842, 3554, 5073, 73363, 7059, 35258, 35493, 10413, 12129, 12125, 14519, 40777 |
| Antidepressants    | Fluphenazine hydrochloride/Nortriptyline hydrochloride | 2936, 7780 |
| Antidepressants    | Imipramine hydrochloride                         | 1310, 41681, 34222, 67935, 71253, 70287, 32863, 34872, 1809, 34813, 34355, 41408, 8055, 42247, 33074, 2579, 56501, 7910, 4404 |
| Antidepressants    | Iprindole                                        | 27476, 27733, 24700, 31672 |
| Antidepressants    | Lofepramine                                       | 79397 |
| Antidepressants    | Mianserin hydrochloride                          | 58450, 2093, 41627, 114, 34046, 34950, 71067, 74586, 66100, 34578, 68657, 67742, 56703, 34672, 60591, 56229, 43534, 4218, 77717, 25444 |
| Antidepressants    | Mianserin hydrochloride                          | 7468, 8144, 8585, 3083, 47363, 4329, 6255, 12368, 11956, 12192 |
| Antidepressants                  | Nortriptyline hydrochloride | 7677                        |
|---------------------------------|-------------------------------|----------------------------|
|                                 | Nortriptyline hydrochloride/  | 8493, 14578, 20571          |
| Fluphenazine hydrochloride      |                               |                            |
|                                 | Protriptyline hydrochloride   | 60929, 7755, 7816, 11187, 7756 |
|                                 | Trazodone hydrochloride       | 4194, 4003, 4874, 8174, 13621, 1730, 34580, 73639, 19181, 41709, 41710, 65152, 72291, 66749, 12710, 4020, 73419, 79715, 73636, 76480, 30983, 29857, 34470, 55137, 55138, 57226, 3355, 7756, 7755, 71021, 74747, 61657, 69355 |
|                                 | Trimipramine maleate          | 8928, 2532, 2531, 4310, 42228, 53808, 2039, 45226, 57978, 66493, 3196, 65445, 66919, 65213 |
|                                 | Viloxazine Hydrochloride      | 12309, 12111                |
|                                 | Citalopram hydrobromide       | 3861, 79784, 63953, 1712, 2408, 34498, 476, 34586, 64423, 32848, 49165, 42660, 52100, 59650, 53787, 71005, 33720, 52408, 34436, 45286, 75697, 52824, 59193, 63441, 34499, 60888, 41528, 56355, 34413, 54827, 34722, 67, 34356, 67907, 34871, 53394, 48026, 56009, 58476, 52607, 52354, 34415, 34970, 73417, 72373, 26016, 34966, 60568, 34822, 71848, 43519, 4770, 36746, 69571, 46977, 75075, 60839, 70790, 55033, 75702, 34603, 45223, 34466, 45304, 46926, 32546, 29756, 74753, 815, 513, 57936, 56292, 72124 |
|                                 | Escitalopram oxalate          | 74785, 648, 74858, 26056, 6360, 41062, 785, 603, 63916, 74993, 20152, 6218, 72773, 40726, 6405 |
|                                 | Fluoxetine hydrochloride      | 33071, 67431, 69941, 77881, 42499, 75645, 38890, 22, 19183, 71852, 45329, 60962, 75799, 67736, 45707, 75688, 34202, 34294, 69525, 59358, 66744, 34288, 42107, 62155, 19470, 45224, 67769, 34456, 34849, 67092, 45316, 33410, 60534, 60138, 2548, 34216, 42803, 60619, 73414, 30258, 36893, 68266, 69685, 74886, 67496, 79590, 67562, 75068, 78889, 4075, 75247, 67888, 34856, 62335, 14740, 67758, 77381, 418, 48220, 61335, 69542, 57532, 252, 75943, 4907, 37256, 33779, 29786 |
|                                 | Fluvoxamine maleate           | 12123, 2897, 2290, 40845, 44861, 43518, 2880 |
|                                 | Nefazodone hydrochloride      | 3391, 4297, 63827, 4554, 4011, 67757 |
|                                 | Paroxetine hydrochloride      | 35021, 76946, 59288, 67259, 527, 50, 34419, 32899, 73668, 40892, 34351, 55023, 33978, 1397, 34587, 40165, 64785, 78843, 68325, 35112, 66292, 74588, 841, 73589, 77650, 3601, 1575, 55537, 76772, 79383, 79381, 75054 |
|                                 | Sertraline                    | 65771                       |

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| Antidepressants         | Drug                           | Codes                          |
|-------------------------|--------------------------------|--------------------------------|
| Antidepressants         | Sertraline hydrochloride       | 4352, 77385, 1612, 727, 55146, 62950, 61503, 59600, 62692, 69726, 67928, 66560, 54933, 66413, 68756, 44944, 73962, 49519, 77607, 78278, 62819, 54826, 78626, 73759, 54081, 488, 32401, 58723, 42387, 45915, 62693, 69725, 63481, 58664, 67730, 69898, 55488, 75952, 62927, 75405, 7328, 77538, 77707 |
| Antidepressants         | Agomelatine                    | 40494, 40295                   |
| Antidepressants         | Duloxetine hydrochloride       | 74774, 712, 13151, 62688, 63370, 65618, 65809, 66412, 70405, 70728, 73298, 74907, 79628, 6895, 14849, 51383, 63216, 64442, 65888, 65892, 66405, 68096, 69428, 69752, 69965, 72211, 73540, 73686, 74190, 78777, 76857 |
| Antidepressants         | Mirtazapine                    | 6421, 43253, 64101, 43241, 66580, 61856, 43248, 43246, 68680, 55482, 58291, 77865, 65555, 43237, 48698, 54012, 6795, 43239, 53699, 66183, 59953, 46668, 66752, 43242, 54342, 54644, 74557, 43257, 16154, 53321, 61547, 58664, 67730, 69898, 55488, 75952, 62927, 75405, 7328, 77538, 77707 |
| Antidepressants         | Nefazodone Hydrochloride       | 9534                           |
| Antidepressants         | Reboxetine mesilate            | 15163, 2356                    |
| Antidepressants         | Tryptophan                     | 54747, 5611, 20504, 12221, 54686, 4422 |
| Antidepressants         | Venlafaxine hydrochloride      | 52516, 52074, 71806, 61236, 45664, 45959, 65738, 67271, 623, 6274, 67288, 77089, 9182, 74010, 5710, 51280, 65899, 74011, 75894, 1474, 76771, 43968, 43673, 41299, 48199, 41314, 41033, 59753, 60843, 40817, 40815, 39809, 39770, 57751, 52716, 40514, 40515, 70420, 70495, 69819, 70315, 50081, 59035, 45111, 58726, 74516, 58681, 55501, 2654, 70806, 60549, 71782, 43334, 39360, 50934, 62734, 65666, 40054, 58837, 45806, 301, 56662, 73667, 68050, 75525, 59923, 70353, 51631, 60895, 51699, 13237, 2617, 470, 71257, 59563, 8876, 43203, 39359, 1222, 60449, 73658, 66437, 56457, 63859, 53326, 63268, 40062, 40407, 45818, 40059, 44936, 44937, 71932, 70931, 40092, 67563, 40277, 76727, 75263, 40517, 42600, 40764, 40917, 40049, 78585, 40048, 75848, 55424 |
| Antidepressants         | Vortioxetine hydrobromide      | 67874, 69991, 69992, 65483, 66890, 65482 |
| Antidepressants         | Iproniazide                    | 25945, 18290                   |
| Antidepressants         | Isocarboxazid                  | 41731, 12207, 12503            |
| Antidepressants         | Moclobemide                    | 9206, 5832, 2883, 67305, 41747, 5187 |
| Antidepressants         | Phenelzine sulfate             | 3349, 4321                    |
| Antidepressants         | Tranylcypromine sulfate        | 10787, 3783, 41654            |
| Antidepressants         | Trifluoperazine Hydrochloride/Tranylcypromine Sulphate | 3356 |
| Category          | Substance                               | Code Numbers                                    |
|-------------------|-----------------------------------------|-------------------------------------------------|
| Antidepressants   | Trifluoperazine Hydrochloride/Tranylcypromine Sulphate | 3955, 24890                                    |
| Corticosteroids   | Dexamethasone Sodium Phosphate           | 28215, 37500, 14906, 61316, 53173, 19259, 47598, 61958, 56940, 35453, 10657, 13972, 26299, 13952, 26454, 31948, 34083, 4233 |
| Corticosteroids   | Hydrocortisone acetate                   | 8108, 1893                                      |
| Corticosteroids   | Lidocaine Hydrochloride/Methylprednisolone Acetate | 925, 20157, 50253, 49076, 50734, 7405, 35156  |
| Corticosteroids   | Methylprednisolone                       | 18042, 8261, 10683, 15555, 14172, 10552, 76923, 10684, 2130 |
| Corticosteroids   | Methylprednisolone acetate               | 48800, 48748, 48746, 14982, 71106, 27413, 33132, 35349, 35040, 35688, 1133, 5493 |
| Corticosteroids   | Methylprednisolone sodium succinate      | 18266, 13397, 12405, 18765, 14188, 25226, 25839, 23511, 21540 |
| Corticosteroids   | Triamcinolone acetonide                  | 14962, 35578, 14335, 14958, 50216, 22047, 50026, 33131, 16583, 48406, 9368, 11123, 4488, 30244, 4125, 4123, 8864, 13981, 768, 37737, 3703, 16582 |
| Corticosteroids   | Triamcinolone hexacetonide               | 50854, 50853, 57856, 66867, 15016, 7992         |
| Corticosteroids   | Betamethasone                            | 10864, 11149, 7286, 64235, 68306, 1971, 50225   |
| Corticosteroids   | Cortisone acetate                        | 12398, 229, 53143, 7548, 53705, 18637, 12400, 10574, 23210 |
| Corticosteroids   | Deflazacort                              | 22555, 29112, 20577, 41335, 9375, 78839, 17410, 3992 |
| Corticosteroids   | Dexamethasone                            | 53207, 9994, 34801, 71926, 78335, 45234, 66724, 56443, 76339, 77085, 52396, 77849, 74156, 74157, 36055, 1280, 62909, 60120, 34880, 68182, 64747, 5157, 54793, 70611, 78214, 70893, 68489, 72537, 69572, 4779, 55401, 34915, 186, 74436, 56347, 68593, 73216, 21903 |
| Corticosteroids   | Hydrocortisone                           | 75064, 74502, 75065, 76671, 3418, 65984, 64787, 66666, 38022, 75019, 51849, 51872, 64059, 54794, 4535, 66327, 57931, 75384, 77646, 51871, 75937, 52053, 75020, 53953, 63138, 14076, 51722, 51824, 75729, 74497, 71620, 38054, 10754, 6098, 13043, 77994, 58592, 59418 |
| Corticosteroids   | Hydrocortisone sodium phosphate          | 35172, 35175, 71905, 37638, 43355, 77821, 9574, 2615 |
| Corticosteroids   | Hydrocortisone sodium succinate          | 49707, 49498, 51167, 54715, 34166, 13350, 3754, 3651 |
| Corticosteroids | Prednisolone       | 78546, 27962, 28859, 25272, 23512, 20095, 34914, 5913, 5490, 59283, 34631, 66645, 66015, 80110, 59229, 69568, 78129, 64007, 64008, 64009, 69686, 64128, 63172, 58234, 65626, 34109, 9727, 33691, 64416, 74239, 66914, 72421, 80050, 578, 34452, 34404, 73553, 58384, 63549, 28376, 2368, 38407, 61132, 75001, 34660, 51753, 34748, 56891, 34978, 59338, 557, 28375, 34461, 76020, 55480, 79930, 68497, 63066, 73294, 54434, 63082, 67076, 53313, 2704, 53336, 78144, 41745, 65020, 54118, 67507, 69811, 44, 31532, 66550, 67107, 73678, 58987, 34303, 59912, 45302, 75763, 39988, 33990, 95, 21417, 29333, 58000, 34781, 60421, 41515, 55024, 63791, 67559, 61162, 32835, 64221 |
| Corticosteroids | Prednisolone sodium phosphate | 1063, 47142, 955, 61689, 74493, 63214, 19141, 78789, 70603, 77760, 24224 |
| Corticosteroids | Prednisolone Steaglate | 31327, 3345 |
| Corticosteroids | Prednisone       | 21833, 54432, 44803, 44802, 44380, 3557, 46711, 58061, 44723, 62656, 43544, 2949 |
| Corticosteroids | Triamcinolone Acetonide | 24014, 15617, 19908, 23111 |
Table S6: Missing data

|                                | How missingness was handled in analysis | Women external validation cohort | Men external validation cohort | All patients original QFracture internal validation cohort |
|--------------------------------|----------------------------------------|----------------------------------|--------------------------------|----------------------------------------------------------|
|                                |                                        | N=2747409                        | N=2684730                      | N=1583373                                                 |
|                                |                                        | No (%) missing data              | No (%) missing data            | No (%) missing data                                       |
| Age                            | Never missing                          | 0                                | 0                              | 0                                                         |
| Sex                            | Never missing                          | 0                                | 0                              | 0                                                         |
| Socioeconomic status           | Excluded from cohort                   | 0                                | 0                              | 0                                                         |
| Body mass index (BMI)          | Imputed                                | 932720 (34.0)                    | 1233196 (45.9)                 | 418478 (26.4)                                             |
| Smoking status                 | Imputed                                | 780226 (28.4)                    | 963580 (35.9)                  | 258144 (16.3)                                             |
| Alcohol status                 | Imputed                                | 698902 (25.4)                    | 866622 (32.3)                  | 461740 (29.2)                                             |
| Ethnicity                      | Assumed to be white                    | 1278931 (46.6)                   | 1494450 (55.7)                 | 855485 (54.0)                                             |
| Conditions and prescribing variables | Assumed to be absent if no record    | NA                               | NA                             | NA                                                       |
Table S7: Crude incidence of major osteoporotic fracture (MOF) over 10 years of follow-up

| Age  | Incident MOF | Total follow-up Years | Rate per 1000 person-years | Incident MOF | Total follow-up Years | Rate per 1000 person-years |
|------|--------------|-----------------------|-----------------------------|--------------|-----------------------|-----------------------------|
| 30-34 | 2,603        | 2741657               | 0.95 (0.91 to 0.99)         | 2,828        | 2784175               | 1.02 (0.98 to 1.05)         |
| 35-39 | 2,025        | 1870595               | 1.08 (1.04 to 1.13)         | 2,121        | 1927589               | 1.10 (1.05 to 1.15)         |
| 40-44 | 2,698        | 1833507               | 1.47 (1.42 to 1.53)         | 2,222        | 1917796               | 1.16 (1.11 to 1.21)         |
| 45-49 | 3,633        | 1595805               | 2.28 (2.20 to 2.35)         | 2,239        | 1681808               | 1.33 (1.28 to 1.39)         |
| 50-54 | 5,292        | 1449369               | 3.65 (3.55 to 3.75)         | 2,248        | 1497499               | 1.50 (1.44 to 1.56)         |
| 55-59 | 7,422        | 1490080               | 4.98 (4.87 to 5.10)         | 2,644        | 1505675               | 1.76 (1.69 to 1.82)         |
| 60-64 | 7,762        | 1210157               | 6.41 (6.27 to 6.56)         | 2,743        | 1191801               | 2.30 (2.22 to 2.39)         |
| 65-69 | 9,455        | 1024227               | 9.23 (9.05 to 9.42)         | 2,859        | 960815                | 2.98 (2.87 to 3.09)         |
| 70-74 | 11,757       | 861260                | 13.65 (13.41 to 13.90)      | 3,456        | 748844                | 4.62 (4.46 to 4.77)         |
| 75-80 | 14,148       | 688855                | 20.54 (20.21 to 20.88)      | 4,068        | 516507                | 7.88 (7.64 to 8.12)         |
| 80-84 | 14,653       | 508415                | 28.82 (28.36 to 29.28)      | 3,891        | 304005                | 12.80 (12.41 to 13.20)      |
| 85-90 | 9,017        | 237728                | 37.93 (37.17 to 38.71)      | 2,080        | 107018                | 19.44 (18.63 to 20.28)      |
| 90-99 | 5,133        | 112888                | 45.47 (44.27 to 46.70)      | 922          | 36093                 | 25.55 (23.97 to 27.22)      |
| Total | 95,598       | 15624543              | 6.12 (6.08 to 6.16)         | 34,321       | 15179623              | 2.26 (2.24 to 2.29)         |
| Age  | Women | Total Follow-up Years | Rate per 1000 person-years | Men | Total Follow-up Years | Rate per 1000 person-years |
|------|-------|-----------------------|----------------------------|-----|-----------------------|----------------------------|
| 30-34 | 93    | 2750441 | 0.03 (0.03 to 0.04) | 214 | 2793615 | 0.08 (0.07 to 0.09) |
| 35-39 | 109   | 1878222 | 0.06 (0.05 to 0.07) | 223 | 1935329 | 0.12 (0.10 to 0.13) |
| 40-44 | 183   | 1842965 | 0.10 (0.09 to 0.11) | 307 | 1925573 | 0.16 (0.14 to 0.18) |
| 45-49 | 374   | 1607632 | 0.23 (0.21 to 0.26) | 377 | 1689307 | 0.22 (0.20 to 0.25) |
| 50-54 | 599   | 1467062 | 0.41 (0.38 to 0.44) | 442 | 1504825 | 0.29 (0.27 to 0.32) |
| 55-59 | 1,149 | 1515268 | 0.76 (0.72 to 0.80) | 701 | 1513119 | 0.46 (0.43 to 0.50) |
| 60-64 | 1,554 | 1234523 | 1.26 (1.20 to 1.32) | 948 | 1197990 | 0.79 (0.74 to 0.84) |
| 65-69 | 2,614 | 1051678 | 2.49 (2.39 to 2.58) | 1,217 | 966352 | 1.26 (1.19 to 1.33) |
| 70-74 | 4,460 | 889669 | 5.01 (4.87 to 5.16) | 1,709 | 754325 | 2.27 (2.16 to 2.38) |
| 75-80 | 6,905 | 715572 | 9.65 (9.43 to 9.88) | 2,432 | 521184 | 4.67 (4.48 to 4.86) |
| 80-84 | 8,752 | 527816 | 16.58 (16.24 to 16.93) | 2,640 | 307196 | 8.59 (8.27 to 8.93) |
| 85-90 | 5,968 | 246247 | 24.24 (23.64 to 24.85) | 1,469 | 108226 | 13.57 (12.90 to 14.28) |
| 90-99 | 3,640 | 115681 | 31.47 (30.48 to 32.49) | 700 | 36423 | 19.22 (17.86 to 20.68) |
| Total | 36,400 | 15842775 | 2.30 (2.27 to 2.32) | 13,379 | 15253462 | 0.88 (0.86 to 0.89) |
### Table S9: Comparison of major osteoporotic fracture (MOF) incidence in this study and previous external validation study\(^a\)

| Age   | Women MOF rate/1000 person-years (this study) | Men MOF rate/1000 person-years (this study) | Men MOF rate/1000 person-years (previous external validation) |
|-------|---------------------------------------------|---------------------------------------------|-------------------------------------------------------------|
| 30-34 | 0.95 (0.91 to 0.99)                         | 1.02 (0.98 to 1.05)                         | 0.45 (0.41 to 0.50)                                         |
| 35-39 | 1.08 (1.04 to 1.13)                         | 1.10 (1.05 to 1.15)                         | 0.45 (0.41 to 0.49)                                         |
| 40-44 | 1.47 (1.42 to 1.53)                         | 1.16 (1.11 to 1.21)                         | 0.44 (0.39 to 0.49)                                         |
| 45-49 | 2.28 (2.20 to 2.35)                         | 1.33 (1.28 to 1.39)                         | 0.55 (0.50 to 0.61)                                         |
| 50-54 | 3.65 (3.55 to 3.75)                         | 1.50 (1.44 to 1.56)                         | 0.67 (0.61 to 0.73)                                         |
| 55-59 | 4.98 (4.87 to 5.10)                         | 1.76 (1.69 to 1.82)                         | 0.74 (0.67 to 0.81)                                         |
| 60-64 | 6.41 (6.27 to 6.56)                         | 2.30 (2.22 to 2.39)                         | 0.98 (0.89 to 1.07)                                         |
| 65-69 | 9.23 (9.05 to 9.42)                         | 2.98 (2.87 to 3.09)                         | 1.42 (1.31 to 1.54)                                         |
| 70-74 | 13.65 (13.41 to 13.90)                      | 8.07 (7.79 to 8.36)                         | 4.62 (4.46 to 4.77)                                         |
| 75-80 | 20.54 (20.21 to 20.88)                      | 11.96 (11.57 to 12.35)                      | 7.88 (7.64 to 8.12)                                         |
| 80-84 | 28.82 (28.36 to 29.28)                      | 17.70 (17.14 to 18.28)                      | 12.80 (12.41 to 13.20)                                      |
| 85-89 | 37.93 (37.17 to 38.71)                      | 19.44 (18.63 to 20.28)                      | -                                                           |
| 90-99 | 45.47 (44.27 to 46.70)                      | 25.55 (23.97 to 27.22)                      | -                                                           |
| Total | 6.12 (6.08 to 6.16)                         | 2.93 (2.89 to 2.98)                         | 0.98 (0.95 to 1.00)                                         |

\(^a\) QFracture derivation papers do not report incidence by age, so the external validation study data is the comparison. As with QFracture derivation and internal validation, the external validation study ascertained fractures using GP electronic health record data and mortality registration data, whereas this study also used fractures recorded at hospital discharge.

\(^b\) Previous external validation study maximum age is 85; in this study maximum age is 99.
Table S10: Comparison of hip fracture incidence in this study and previous external validation study

| Age  | Hip fracture rate/1000 person-years (this study) | Hip fracture rate/1000 person-years (previous external validation) | Hip fracture rate/1000 person-years (this study) | Hip fracture rate/1000 person-years (previous external validation) |
|------|-----------------------------------------------|---------------------------------------------------------------|-----------------------------------------------|---------------------------------------------------------------|
| 30-34| 0.03 (0.03 to 0.04)                            | 0.03 (0.02 to 0.05)                                           | 0.08 (0.07 to 0.09)                          | 0.05 (0.04 to 0.06)                                           |
| 35-39| 0.06 (0.05 to 0.07)                            | 0.04 (0.03 to 0.06)                                           | 0.12 (0.10 to 0.13)                          | 0.08 (0.07 to 0.10)                                           |
| 40-44| 0.10 (0.09 to 0.11)                            | 0.08 (0.06 to 0.10)                                           | 0.16 (0.14 to 0.18)                          | 0.09 (0.07 to 0.12)                                           |
| 45-49| 0.23 (0.21 to 0.26)                            | 0.18 (0.15 to 0.21)                                           | 0.22 (0.20 to 0.25)                          | 0.15 (0.13 to 0.18)                                           |
| 50-54| 0.41 (0.38 to 0.44)                            | 0.31 (0.27 to 0.35)                                           | 0.29 (0.27 to 0.32)                          | 0.22 (0.19 to 0.26)                                           |
| 55-59| 0.76 (0.72 to 0.80)                            | 0.56 (0.50 to 0.62)                                           | 0.46 (0.43 to 0.50)                          | 0.31 (0.27 to 0.36)                                           |
| 60-64| 1.26 (1.20 to 1.32)                            | 1.01 (0.93 to 1.10)                                           | 0.79 (0.74 to 0.84)                          | 0.43 (0.37 to 0.49)                                           |
| 65-69| 2.49 (2.39 to 2.58)                            | 1.97 (1.85 to 2.10)                                           | 1.26 (1.19 to 1.33)                          | 0.79 (0.70 to 0.87)                                           |
| 70-74| 5.01 (4.87 to 5.16)                            | 3.97 (3.78 to 4.17)                                           | 2.27 (2.16 to 2.38)                          | 1.67 (1.54 to 1.82)                                           |
| 75-80| 9.65 (9.43 to 9.88)                            | 7.03 (6.75 to 7.32)                                           | 4.67 (4.48 to 4.86)                          | 2.84 (2.62 to 3.08)                                           |
| 80-84| 16.58 (16.24 to 16.93)                         | 12.47 (12.02 to 12.94)                                        | 8.59 (8.27 to 8.93)                          | 5.42 (5.01 to 5.86)                                           |
| 85-90 | 24.24 (23.64 to 24.85)                          | 13.57 (12.90 to 14.28)                                        |                                                |                                                               |
| 90-99 | 31.47 (30.48 to 32.49)                          | 19.22 (17.86 to 20.68)                                        |                                                |                                                               |
| Total| 2.30 (2.27 to 2.32)                            | 1.37 (1.35 to 1.40)                                           | 0.88 (0.86 to 0.89)                          | 0.47 (0.46 to 0.49)                                           |

a. QFracture derivation papers do not report incidence by age, so the external validation study data is the comparison. As with QFracture derivation and internal validation, the external validation study ascertained fractures using GP electronic health record data and mortality registration data, whereas this study also used fractures recorded at hospital discharge

b. Previous external validation study maximum age is 85; in this study maximum age is 99; reported previous external validation rate is therefore for age 80-85
Table S11: Crude incidence of major osteoporotic fracture (MOF) over 10 years of follow-up (with ascertainment restricted to GP and mortality data)

| Age   | Women | Men | Rate per 1000 person-years |
|-------|-------|-----|----------------------------|
|       | Incident MOF | Total follow-up Years | Rate per 1000 person-years | Incident MOF | Total follow-up Years | Rate per 1000 person-years |
| 30-34 | 2,316 | 2742607 | 0.84 (0.81 to 0.88) | 2,447 | 2785431 | 0.88 (0.84 to 0.91) |
| 35-39 | 1,788 | 1871469 | 0.96 (0.91 to 1.00) | 1,848 | 1928588 | 0.96 (0.92 to 1.00) |
| 40-44 | 2,387 | 1834615 | 1.30 (1.25 to 1.35) | 1,897 | 1918981 | 0.99 (0.95 to 1.03) |
| 45-49 | 3,212 | 1597368 | 2.01 (1.94 to 2.08) | 1,914 | 1682894 | 1.14 (1.09 to 1.19) |
| 50-54 | 4,747 | 1451234 | 3.27 (3.18 to 3.37) | 1,902 | 1498727 | 1.27 (1.21 to 1.33) |
| 55-59 | 6,569 | 1493186 | 4.40 (4.29 to 4.51) | 2,160 | 1507164 | 1.43 (1.37 to 1.49) |
| 60-64 | 6,829 | 1213292 | 5.63 (5.50 to 5.76) | 2,221 | 1193239 | 1.86 (1.79 to 1.94) |
| 65-69 | 8,116 | 1028487 | 7.89 (7.72 to 8.06) | 2,293 | 962282 | 2.38 (2.29 to 2.48) |
| 70-74 | 9,965 | 866524 | 11.50 (11.28 to 11.73) | 2,752 | 750538 | 3.67 (3.53 to 3.81) |
| 75-80 | 11,693 | 695373 | 16.82 (16.52 to 17.12) | 3,247 | 518140 | 6.27 (6.06 to 6.49) |
| 80-84 | 11,873 | 514580 | 23.07 (22.67 to 23.49) | 3,041 | 305425 | 9.96 (9.61 to 10.31) |
| 85-89 | 7,175 | 241340 | 29.73 (29.06 to 30.41) | 1,576 | 107622 | 14.64 (13.94 to 15.38) |
| 90-99 | 4,126 | 114095 | 36.16 (35.09 to 37.26) | 718 | 36261 | 19.80 (18.42 to 21.29) |
| Total | 80,796 | 15664170 | 5.16 (5.12 to 5.19) | 28,016 | 15195293 | 1.84 (1.82 to 1.87) |
Table S12: Comparison of major osteoporotic fracture incidence in this study with complete fracture ascertainment (GP, mortality and hospital admission data), previous external validation study, and in this study using ascertainment to match previous study (GP and mortality data only)

| Age  | Women MOF rate/1000 person-years (this study)\(^a\) | Women MOF rate/1000 person-years (previously published external validation)\(^b\) | Women MOF rate/1000 person-years (this study matched ascertainment)\(^b\) | Men MOF rate/1000 person-years (this study)\(^a\) | Men MOF rate/1000 person-years (previously published external validation)\(^b\) | Men MOF rate/1000 person-years (this study matched ascertainment)\(^b\) |
|------|--------------------------------------------------|-------------------------------------------------|-------------------------------------------------|---------------------------------|-------------------------------------------------|-------------------------------------------------|
| 30-34| 0.95 (0.91 to 0.99)                              | 0.03 (0.02 to 0.05)                             | 0.84 (0.81 to 0.88)                             | 1.02 (0.98 to 1.05)             | 0.05 (0.04 to 0.06)                             | 0.88 (0.84 to 0.91)                             |
| 35-39| 1.08 (1.04 to 1.13)                              | 0.04 (0.03 to 0.06)                             | 0.96 (0.91 to 1.00)                             | 1.10 (1.05 to 1.15)             | 0.08 (0.07 to 0.10)                             | 0.96 (0.92 to 1.00)                             |
| 40-44| 1.47 (1.42 to 1.53)                              | 0.08 (0.06 to 0.10)                             | 1.30 (1.25 to 1.35)                             | 1.16 (1.11 to 1.21)             | 0.09 (0.07 to 0.12)                             | 0.99 (0.95 to 1.03)                             |
| 45-49| 2.28 (2.20 to 2.35)                              | 0.18 (0.15 to 0.21)                             | 2.01 (1.94 to 2.08)                             | 1.33 (1.28 to 1.39)             | 0.15 (0.13 to 0.18)                             | 1.14 (1.09 to 1.19)                             |
| 50-54| 3.65 (3.55 to 3.75)                              | 0.31 (0.27 to 0.35)                             | 3.27 (3.18 to 3.37)                             | 1.50 (1.44 to 1.56)             | 0.22 (0.19 to 0.26)                             | 1.27 (1.21 to 1.33)                             |
| 55-59| 4.98 (4.87 to 5.10)                              | 0.56 (0.50 to 0.62)                             | 4.40 (4.29 to 4.51)                             | 1.76 (1.69 to 1.82)             | 0.31 (0.27 to 0.36)                             | 1.43 (1.37 to 1.49)                             |
| 60-64| 6.41 (6.27 to 6.56)                              | 1.01 (0.93 to 1.10)                             | 5.63 (5.50 to 5.76)                             | 2.30 (2.22 to 2.39)             | 0.43 (0.37 to 0.49)                             | 1.86 (1.79 to 1.94)                             |
| 65-69| 9.23 (9.05 to 9.42)                              | 1.97 (1.85 to 2.10)                             | 7.89 (7.72 to 8.06)                             | 2.98 (2.87 to 3.09)             | 0.79 (0.70 to 0.87)                             | 2.38 (2.29 to 2.48)                             |
| 70-74| 13.65 (13.41 to 13.90)                           | 3.97 (3.78 to 4.17)                             | 11.50 (11.28 to 11.73)                          | 4.62 (4.46 to 4.77)             | 1.67 (1.54 to 1.82)                             | 3.67 (3.53 to 3.81)                             |
| 75-80| 20.54 (20.21 to 20.88)                           | 7.03 (6.75 to 7.32)                             | 16.82 (16.52 to 17.12)                          | 7.88 (7.64 to 8.12)             | 2.84 (2.62 to 3.08)                             | 6.27 (6.06 to 6.49)                             |
| 80-84| 28.82 (28.36 to 29.28)                           | 12.47 (12.02 to 12.94)                          | 23.07 (22.67 to 23.49)                          | 12.80 (12.41 to 13.20)          | 5.42 (5.01 to 5.86)                             | 9.96 (9.61 to 10.31)                            |
| 85-90 | 37.93 (37.17 to 38.71)                           | -                                               | 29.73 (29.06 to 30.41)                          | 19.44 (18.63 to 20.28)          | -                                               | 14.64 (13.94 to 15.38)                          |
| 90-99 | 45.47 (44.27 to 46.70)                           | -                                               | 36.16 (35.09 to 37.26)                          | 25.55 (23.97 to 27.22)          | -                                               | 19.80 (18.42 to 21.29)                          |
| Total| 6.12 (6.08 to 6.16)                              | 1.37 (1.35 to 1.40)                             | 5.16 (5.12 to 5.19)                             | 2.26 (2.24 to 2.29)             | 0.47 (0.46 to 0.49)                             | 1.84 (1.82 to 1.87)                             |

a. Fractures ascertained using GP electronic health record data, mortality registration data, and fractures recorded at hospital discharge
b. Fractures ascertained using GP electronic health record data and mortality registration data (but NOT hospital discharge data)
c. Previous external validation study maximum age is 85; in this study maximum age is 99; reported previous external validation rate is therefore for age 80-85
Table S13: Crude incidence of hip fracture over 10 years of follow-up (with ascertainment restricted to GP and mortality data)

| Age  | Women |            |            | Men   |            |            |
|------|-------|------------|------------|-------|------------|------------|
|      | Incident hip fracture | Total follow-up Years | Rate per 1000 person-years | Incident hip fracture | Total follow-up Years | Rate per 1000 person-years |
| 30-34| 80    | 2750475    | 0.03 (0.02 to 0.04) | 178   | 2793683    | 0.06 (0.06 to 0.07) |
| 35-39| 92    | 1878252    | 0.05 (0.04 to 0.06) | 192   | 1935416    | 0.10 (0.09 to 0.11) |
| 40-44| 158   | 1843032    | 0.09 (0.07 to 0.10) | 254   | 1925741    | 0.13 (0.12 to 0.15) |
| 45-49| 325   | 1607799    | 0.20 (0.18 to 0.23) | 322   | 1689484    | 0.19 (0.17 to 0.21) |
| 50-54| 524   | 1467273    | 0.36 (0.33 to 0.39) | 369   | 1505015    | 0.25 (0.22 to 0.27) |
| 55-59| 975   | 1515801    | 0.64 (0.60 to 0.68) | 571   | 1513458    | 0.38 (0.35 to 0.41) |
| 60-64| 1,325 | 1235112    | 1.07 (1.02 to 1.13) | 792   | 1198354    | 0.66 (0.62 to 0.71) |
| 65-69| 2,194 | 1052811    | 2.08 (2.00 to 2.17) | 993   | 966812     | 1.03 (0.97 to 1.09) |
| 70-74| 3,644 | 891687     | 4.09 (3.96 to 4.22) | 1,388 | 754978     | 1.84 (1.74 to 1.94) |
| 75-80| 5,570 | 718657     | 7.75 (7.55 to 7.96) | 1,970 | 521983     | 3.77 (3.61 to 3.94) |
| 80-84| 6,992 | 531298     | 13.16 (12.86 to 13.47) | 2,100 | 307978     | 6.82 (6.53 to 7.12) |
| 85-90| 4,700 | 248552     | 18.91 (18.38 to 19.45) | 1,137 | 108580     | 10.47 (9.88 to 11.09) |
| 90-99| 2,910 | 116419     | 25.00 (24.11 to 25.91) | 558   | 36527      | 15.28 (14.07 to 16.59) |
| Total | 29,489 | 15857168   | 1.86 (1.84 to 1.88) | 10,824 | 15258010   | 0.71 (0.70 to 0.72) |
Table S14: Comparison of hip fracture incidence in this study with complete fracture ascertainment (GP, mortality and hospital admission data), previous external validation study, and in this study using ascertainment to match previous study (GP and mortality data only)\(^a\)\(^b\)

| Age   | Women                                                                 | Men                                                                 |
|-------|----------------------------------------------------------------------|----------------------------------------------------------------------|
|       | Hip fracture rate/1000 person-years (this study)\(^a\)                | Hip fracture rate/1000 person-years (previously published external validation)\(^b\) |
| 30-34 | 0.03 (0.03 to 0.04)                                                  | 0.03 (0.02 to 0.05)                                                  |
| 35-39 | 0.06 (0.05 to 0.07)                                                  | 0.04 (0.03 to 0.06)                                                  |
| 40-44 | 0.10 (0.09 to 0.11)                                                  | 0.09 (0.07 to 0.10)                                                  |
| 45-49 | 0.23 (0.21 to 0.26)                                                  | 0.20 (0.18 to 0.23)                                                  |
| 50-54 | 0.41 (0.38 to 0.44)                                                  | 0.36 (0.33 to 0.39)                                                  |
| 55-59 | 0.76 (0.72 to 0.80)                                                  | 0.64 (0.60 to 0.68)                                                  |
| 60-64 | 1.26 (1.20 to 1.32)                                                  | 1.07 (1.02 to 1.13)                                                  |
| 65-69 | 2.49 (2.39 to 2.58)                                                  | 2.08 (2.00 to 2.17)                                                  |
| 70-74 | 5.01 (4.87 to 5.16)                                                  | 4.09 (3.96 to 4.22)                                                  |
| 75-80 | 9.65 (9.43 to 9.88)                                                  | 7.75 (7.55 to 7.96)                                                  |
| 80-84 | 16.58 (16.24 to 16.93)                                               | 13.16 (12.86 to 13.47)                                               |
| 85-90c| 24.24 (23.64 to 24.85)                                               | 18.91 (18.38 to 19.45)                                               |
| 90-99c| 31.47 (30.48 to 32.49)                                               | 25.00 (24.11 to 25.91)                                               |
| Total | 2.30 (2.27 to 2.32)                                                  | 1.37 (1.35 to 1.40)                                                  |

\(^a\) Fractures ascertainment using GP electronic health record data, mortality registration data, and fractures recorded at hospital discharge

\(^b\) Fractures ascertainment using GP electronic health record data and mortality registration data (but NOT hospital discharge data)

\(^c\) Previous external validation study maximum age is 85; in this study maximum age is 99; reported previous external validation rate is therefore for age 80-85

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Figure S1: Comparison of fracture incidence in this study (using GP, mortality and hospital admission data), previous external validation (using GP and ONS data but maximum age 85)\(^3\) and this study matched to previous external validation ascertainment (using GP and ONS data)*

* The previous external validation\(^1\) is of the first version of the QFracture tool\(^4\) but the derivation paper for the second version\(^5\) being evaluated in this study does not report fracture incidence by age. Key differences are that the external validation study only includes patients to age 84 years (vs to 99 years in this study), and excludes people with prior major osteoporotic fracture (who are included in this study, since prior MOF is a predictor)
Table S15: Crude incidence of non-fracture death over 10 years of follow-up

| Age   | Women Incident non-fracture death | Total follow-up Years | Rate per 1000 person-years | Men Incident non-fracture death | Total follow-up Years | Rate per 1000 person-years |
|-------|----------------------------------|-----------------------|----------------------------|---------------------------------|-----------------------|-----------------------------|
| 30-34 | 1,348                            | 2741657               | 0.49 (0.47 to 0.52)        | 2,346                           | 2784175               | 0.84 (0.81 to 0.88)         |
| 35-39 | 1,677                            | 1870595               | 0.90 (0.85 to 0.94)        | 2,411                           | 1927589               | 1.25 (1.20 to 1.30)         |
| 40-44 | 2,534                            | 1833507               | 1.38 (1.33 to 1.44)        | 3,605                           | 1917796               | 1.88 (1.82 to 1.94)         |
| 45-49 | 3,714                            | 1595805               | 2.33 (2.25 to 2.40)        | 5,094                           | 1681808               | 3.03 (2.95 to 3.11)         |
| 50-54 | 4,991                            | 1449369               | 3.44 (3.35 to 3.54)        | 7,398                           | 1497499               | 4.94 (4.83 to 5.05)         |
| 55-59 | 7,996                            | 1490080               | 5.37 (5.25 to 5.48)        | 12,167                          | 1505675               | 8.08 (7.94 to 8.23)         |
| 60-64 | 10,378                           | 1210157               | 8.58 (8.41 to 8.74)        | 15,427                          | 1191801               | 12.94 (12.74 to 13.15)      |
| 65-69 | 14,216                           | 1024227               | 13.88 (13.65 to 14.11)     | 20,779                          | 960815                | 21.63 (21.34 to 21.92)      |
| 70-74 | 19,734                           | 861260                | 22.91 (22.60 to 23.23)     | 26,842                          | 748844                | 35.84 (35.43 to 36.27)      |
| 75-80 | 27,874                           | 688855                | 40.46 (40.00 to 40.93)     | 31,087                          | 516507                | 60.19 (59.54 to 60.84)      |
| 80-84 | 36,030                           | 508415                | 70.87 (70.17 to 71.58)     | 30,228                          | 304005                | 99.43 (98.37 to 100.50)     |
| 85-89 | 29,415                           | 237728                | 123.73 (122.42 to 125.06)  | 16,832                          | 107018                | 157.28 (155.11 to 159.48)   |
| 90-99 | 23,799                           | 112888                | 210.82 (208.45 to 213.21)  | 8,865                           | 36093                 | 245.62 (241.20 to 250.09)   |
| Total | 183,706                          | 15624543              | 11.76 (11.70 to 11.81)     | 183,081                          | 15179623              | 12.06 (12.01 to 12.12)      |
Table S16: Comparison of major osteoporotic fracture (MOF), hip fracture and non-fracture death incidence (rate per 1000 person/years [95%CI])

| Age  | Women Major osteoporotic fracture | Women Hip fracture | Women Non-fracture death | Men Major osteoporotic fracture | Men Hip fracture | Men Non-fracture death |
|------|----------------------------------|-------------------|--------------------------|--------------------------------|----------------|------------------------|
| 30-34| 0.95 (0.91 to 0.99)              | 0.03 (0.03 to 0.04)| 0.49 (0.47 to 0.52)     | 1.02 (0.98 to 1.05)            | 0.08 (0.07 to 0.09)| 0.84 (0.81 to 0.88)  |
| 35-39| 1.08 (1.04 to 1.13)              | 0.06 (0.05 to 0.07)| 0.90 (0.85 to 0.94)     | 1.10 (1.05 to 1.15)            | 0.12 (0.10 to 0.13)| 1.25 (1.20 to 1.30)  |
| 40-44| 1.47 (1.42 to 1.53)              | 0.10 (0.09 to 0.11)| 1.38 (1.33 to 1.44)     | 1.16 (1.11 to 1.21)            | 0.16 (0.14 to 0.18)| 1.88 (1.82 to 1.94)  |
| 45-49| 2.28 (2.20 to 2.35)              | 0.23 (0.21 to 0.26)| 2.33 (2.25 to 2.40)     | 1.33 (1.28 to 1.39)            | 0.22 (0.20 to 0.25)| 3.03 (2.95 to 3.11)  |
| 50-54| 3.65 (3.55 to 3.75)              | 0.41 (0.38 to 0.44)| 3.44 (3.35 to 3.54)     | 1.50 (1.44 to 1.56)            | 0.29 (0.27 to 0.32)| 4.94 (4.83 to 5.05)  |
| 55-59| 4.98 (4.87 to 5.10)              | 0.76 (0.72 to 0.80)| 5.37 (5.25 to 5.48)     | 1.76 (1.69 to 1.82)            | 0.46 (0.43 to 0.50)| 8.08 (7.94 to 8.23)  |
| 60-64| 6.41 (6.27 to 6.56)              | 1.26 (1.20 to 1.32)| 8.58 (8.41 to 8.74)     | 2.30 (2.22 to 2.39)            | 0.79 (0.74 to 0.84)| 12.94 (12.74 to 13.15)|
| 65-69| 9.23 (9.05 to 9.42)              | 2.49 (2.39 to 2.58)| 13.88 (13.65 to 14.11) | 2.98 (2.87 to 3.09)            | 1.26 (1.19 to 1.33)| 21.63 (21.34 to 21.92)|
| 70-74| 13.65 (13.41 to 13.90)           | 5.01 (4.87 to 5.16)| 22.91 (22.60 to 23.23) | 4.62 (4.46 to 4.77)            | 2.27 (2.16 to 2.38)| 35.84 (35.43 to 36.27)|
| 75-80| 20.54 (20.21 to 20.88)           | 9.65 (9.43 to 9.88)| 40.46 (40.00 to 40.93) | 7.88 (7.64 to 8.12)            | 4.67 (4.48 to 4.86)| 60.19 (59.54 to 60.84)|
| 80-84| 28.82 (28.36 to 29.28)           | 16.58 (16.24 to 16.93)| 70.87 (70.17 to 71.58) | 12.80 (12.41 to 13.20)         | 8.59 (8.27 to 8.93)| 99.43 (98.37 to 100.50)|
| 85-89| 37.93 (37.17 to 38.71)           | 24.24 (23.64 to 24.85)| 123.73 (122.42 to 125.06)| 19.44 (18.63 to 20.28)       | 13.57 (12.90 to 14.28)| 157.28 (155.11 to 159.48)|
| 90-99| 45.47 (44.27 to 46.70)           | 31.47 (30.48 to 32.49)| 210.82 (208.45 to 213.21)| 25.55 (23.97 to 27.22)     | 19.22 (17.86 to 20.68)| 245.62 (241.20 to 250.09)|
| Total| 6.12 (6.08 to 6.16)              | 2.30 (2.27 to 2.32)| 11.76 (11.70 to 11.81) | 2.26 (2.24 to 2.29)            | 0.88 (0.86 to 0.89)| 12.06 (12.01 to 12.12)|
Figure S2: Calibration for major osteoporotic fracture in women by age group without accounting for competing risks (left hand) and accounting for competing risks (right hand).

**Women (not accounting for competing risks)**

1a: Aged 30-64

1c: Aged 65-74

1e: Aged 75-84

1g: Aged 85-99

**Women (accounting for competing risks)**

1b: Aged 30-64

1d: Aged 65-74

1f: Aged 75-84

1h: Aged 85-99

* Observed risk is based on the Kaplan-Meier estimator which does not account for competing mortality risk.

# Observed risk is based on the Aalen-Johansen estimator which accounts for competing mortality risk

Coloured line (observed risk) above matching black line (predicted risk) indicates under-prediction; below indicates over-prediction
Figure S3: Calibration for major osteoporotic fracture in men by agegroup without accounting for competing risks (left hand) and accounting for competing risks (right hand)

Men (not accounting for competing risks)
1a: Aged 30-64

Men (accounting for competing risks)
1b: Aged 30-64

1c: Aged 65-74

1d: Aged 65-74

1e: Aged 75-84

1f: Aged 75-84

1g: Aged 85-99

1h: Aged 85-99

* Observed risk is based on the Kaplan-Meier estimator which does not account for competing mortality risk.
# Observed risk is based on the Aalen-Johansen estimator which accounts for competing mortality risk

Coloured line (observed risk) above matching black line (predicted risk) indicates under-prediction; below indicates over-prediction risk
Figure S4: Calibration for major osteoporotic fracture in women by Charlson Score without accounting for competing risks (left hand) and accounting for competing risks (right hand)

Women (not accounting for competing risks)
1a: mCCI=0

Women (accounting for competing risks)
1b: mCCI=0

1c: mCCI=1

1d: mCCI=1

1e: mCCI=2

1f: mCCI=2

1g: mCCI=3+

1h: mCCI=3+

* Observed risk is based on the Kaplan-Meier estimator which does not account for competing mortality risk.
# Observed risk is based on the Aalen-Johansen estimator which accounts for competing mortality risk.
Coloured line (observed risk) above matching black line (predicted risk) indicates under-prediction; below indicates over-prediction.
Figure S55: Calibration for major osteoporotic fracture in men by Charlson Score without accounting for competing risks (left hand) and accounting for competing risks (right hand)

Men (not accounting for competing risks)

1a: mCCI=0

1c: mCCI=1

1e: mCCI=2

1g: mCCI=3+

Men (accounting for competing risks)

1b: mCCI=0

1d: mCCI=1

1f: mCCI=2

1h: mCCI=3+

* Observed risk is based on the Kaplan-Meier estimator which does not account for competing mortality risk.

# Observed risk is based on the Aalen-Johansen estimator which accounts for competing mortality risk.

Coloured line (observed risk) above matching black line (predicted risk) indicates under-prediction; below indicates over-prediction.
Figure S6: Calibration for hip fracture in women by agegroup without accounting for competing risks (left hand) and accounting for competing risks (right hand)

Women (not accounting for competing risks)

1a: Aged 30-64

Women (accounting for competing risks)

1b: Aged 30-64

1c: Aged 65-74

1d: Aged 65-74

1e: Aged 75-84

1f: Aged 75-84

1g: Aged 85-99

1h: Aged 85-99

* Observed risk is based on the Kaplan-Meier estimator which does not account for competing mortality risk.
# Observed risk is based on the Aalen-Johansen estimator which accounts for competing mortality risk

Coloured line (observed risk) above matching black line (predicted risk) indicates under-prediction; below indicates over-prediction
Figure S7: Calibration for hip fracture in men by agegroup without accounting for competing risks (left hand) and accounting for competing risks (right hand)

**Men (not accounting for competing risks)**

1a: Aged 30-64

1c: Aged 65-74

1e: Aged 75-84

1g: Aged 85-99

**Men (accounting for competing risks)**

1b: Aged 30-64

1d: Aged 65-74

1f: Aged 75-84

1h: Aged 85-99

* Observed risk is based on the Kaplan-Meier estimator which does not account for competing mortality risk.

# Observed risk is based on the Aalen-Johansen estimator which accounts for competing mortality risk.

Coloured line (observed risk) above matching black line (predicted risk) indicates under-prediction; below indicates over-prediction.
Figure S8: Calibration for hip fracture in women by Charlson Score without accounting for competing risks (left hand) and accounting for competing risks (right hand)

**Women (not accounting for competing risks)**

1a: mCCI=0

1c: mCCI=1

1e: mCCI=2

1g: mCCI=3+

**Women (accounting for competing risks)**

1b: mCCI=0

1d: mCCI=1

1f: mCCI=2

1h: mCCI=3+

*Observed risk is based on the Kaplan-Meier estimator which does not account for competing mortality risk.
#Observed risk is based on the Aalen-Johansen estimator which accounts for competing mortality risk.
Coloured line (observed risk) above matching black line (predicted risk) indicates under-prediction; below indicates over-prediction.
Figure S9: Calibration for hip fracture in men by Charlon Score without accounting for competing risks (left hand) and accounting for competing risks (right hand)

**Men (not accounting for competing risks)**

1a: mCCI=0

1c: mCCI=1

1e: mCCI=2

1g: mCCI=3+

**Men (accounting for competing risks)**

1b: mCCI=0

1d: mCCI=1

1f: mCCI=2

1h: mCCI=3+

* Observed risk is based on the Kaplan-Meier estimator which does not account for competing mortality risk.

# Observed risk is based on the Aalen-Johansen estimator which accounts for competing mortality risk

Coloured line (observed risk) above matching black line (predicted risk) indicates under-prediction; below indicates over-prediction
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