**Title: Musculoskeletal case-mix adjustment in a UK primary/community care cohort: Testing Musculoskeletal models to make recommendations in this setting.**

**Tables:**

**Table 1: Variables in STarT MSK Trial Dataset & those used in NPROMs and FOTO Models.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Baseline Variables** | **Available in STarT MSK Trial Dataset** | **NPROMs Model (DoH/NHSE, 2012/2013)** | **FOTO Model (Deutscher 2018)** |
| **Characteristics** |  |  |  |
| Age | X | X | X |
| Sex | X | X | X |
| Ethnicity | X | X |  |
| SES-IMD | X | X |  |
| SES-Education |  |  |  |
| SES-Job Title | X |  |  |
| SES-Health Literacy | X |  |  |
| **Baseline Clinical Factors** |  |  |  |
| Pain Site/Body Part/Impairment | X | X | X |
| Comorbidities | X | X | X |
| Duration of Symptoms | X | X | X |
| Previous Surgery | X  | X (2012) | X |
| Previous Pain Episode | X |  |  |
| Previous Treatment |  |  | X |
| General Health |  | X (2012) |  |
| Medication at Intake |  |  | X |
| **Employment** |  |  |  |
| Work Status | X |  |  |
| Work Absence | X |  |  |
| Work Absence Duration | X |  |  |
| Payer |  |  | X |
| **Function/Disability** |  |  |  |
| Pain Intensity | X |  |  |
| Functional PROM Score (e.g. MSK-HQ) | X | X | X |
| Disability/QoL PROM (e.g. EQ5D) | X | X |  |
| Self-reported as Disabled |  | X |  |
| Psychological Distress | X |  |  |
| Fear Avoidance (FABQ, TLS-11) | X |  |  |
| Self-Efficacy | X |  |  |
| Physical Activity | X |  | X |
| **Social Factors** |  |  |  |
| Living Alone | X | X |  |
| Support Needed with Questionnaire |  | X |  |
|  |  |  |  |
| **Model Power** |  |  |  |
| R2 (%) | NA | 23-30% | 30-40% |

**Table 2: Recommendations for variables to include in MSK case-mix adjustment model development**

|  |  |  |  |
| --- | --- | --- | --- |
| **Very strong evidence****Highly Recommended** | **Strong evidence** **Highly Recommended** | **Moderate evidence****Recommended if feasible to collect in addition** | **Limited evidence****Not Recommended for initial inclusion** |
| Age (continuous, 0-120) | Disability(binary self-rated or questionnaire) | Assistance with questionnaire(binary yes/no) | Exercise history(potential list of 3) |
| Baseline PROM score (continuous)  | Duration of symptoms (potential list of 10) | BMI(4 categories) | Fear avoidance(FABQ) |
| Comorbidities (potential list of 11) | Payer/Employment /Sick leave duration(potential list of 10 or sick leave duration list (to be determined)) | Depression/Mental wellbeing(binary/mental wellbeing questionnaire) | General health(potential list of 5) |
|  | Socioeconomic status(IMD 2010 or Education) | Ethnicity(potential list of 5) | Living alone(binary yes/no) |
|  | Surgical history (binary yes/no) | Gender(binary male/female) | Use of medication at intake for condition(binary yes/no) |
|  |  | Impairment type/anatomical body part(potential list of 10) | Vitality(SF36) |
|  |  | Pain intensity(NPRS 0-10) |  |

PROM; Patient Reported Outcome Measure, IMD; Index of Multiple Deprivation, BMI; Body Mass Index, NPRS; Numeric Pain Rating Scale, FABQ, Fear Avoidance Beliefs Questionnaire.

\* Combined findings from Burgess et al 2019, 2020.

**Table 3: Descriptive Statistics**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Descriptive Statistics** |  |  |  |  |
|  | **Mean/frequency(%)** | **SD** | **N** | **% complete data** |
| **N** |  |  | 1211 |  |
| **MSK-HQ score baseline** (mean) | 29.17 | 10.162 | 1208 | 99.75 |
| **MSK-HQ score 6m FU** (mean) | 38.17 | 11.68 | 972 | 80.26 |
| **Age** (mean) | 60.03 | 15.28 | 1211 | 100 |
| **Sex** (female) (f(%)) | 714(59) |  | 1211 | 100 |
| **Ethnicity (f(%))**MixedAsianBlackWhiteOtherPrefer not to say | 8(0.7)5(0.4)4(0.3)1172(97.3)7(0.6)9(0.7) |  | 1205 | 99.50 |
| **SES: Health Literacy (help) (f(%))**NeverRarelySometimesOftenAlways | 973(81.7)102(8.6)73(6.1)32(2.7)11(0.9) |  | 1191 | 98.35 |
| **SES: IMD Decile (f(%))**12345678910 | 19(1.6)31(2.6)84(6.9)109(9.0)114(9.4)159(13.1)171(14.1)212(17.5)160(13.2)153(12.6) |  | 1211 | 100 |
| **Duration (without pain) (f(%))**<3m3-6m7-12m1-2y3-5y6-10yover 10y | 306(25.5)207(17.2)151(12.6)147(12.2)162(13.5)83(6.9)146(12.1) |  | 1202 | 99.26 |
| **Previous Pain Episodes (f(%))**012-34-910+ | 260(21.6)144(12.0)231(19.2)185(15.4)385(32) |  | 1205 | 99.50 |
| **Pain Intensity (NPRS)** (mean) | 6.35 | 2.217 | 1208 | 99.75 |
| **Comorbidity Count** (f(%))0123 or more | 386(31.9)439(36.3)250(20.6)136(11.2) |  | 1211 | 100 |
| **Pain Site** (f(%))KneeNeckBackShoulderMultisite | 379(31.3)130(10.7)457(37.7)130(10.7)116(9.6) |  | 1211 | 100 |
| **Physical Activity (days per week)** (f(%))01234567 | 299(24.8)150(12.4)177(14.7)167(13.8)105(8.7)134(11.1)42(3.5)134(11.1) |  | 1208 | 99.75 |
| **Previous Surgery** (f(%))YesNo | 149(12.2)1019(87.8) |  | 1168 | 96.45 |
| **Living Alone** (f(%))YesNo | 212(17.6)991(82.4) |  | 1203 | 99,34 |
| **EQ5D** (mean index score) | 0.557 | 0.235 | 1171 | 96.70 |
| **FAB-TSK** (mean) | 25.07 | 6.465 | 1186 | 97.94 |
| **Paid Employment** (f(%))YesNo | 561(48.2)604(51.8) |  | 1165 | 96.20 |
| **Self-efficacy** (mean) (0-10) | 5.22 | 2.548 | 1210 | 99.92 |

**f; frequency, NPRS; Numeric Pain Rating Scale, SD; standard deviation**

**Table 4: Univariate Analysis**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Baseline Variables** |  | **95% Confidence Interval for Beta** |  |  |
|  | **Unstandardised Coefficient Beta** | **Lower bound** | **Upper bound** | **Standardised Coefficient Beta** | **P-value** |
| **Characteristics** |  |  |  |  |  |
| **Age** | -0.024 | -0.077 | 0.030 | -0.028 | 0.382 |
| **Sex** | -2.099 | -3.586 | -0.612 | -0.089 | **0.006** |
| **Ethnicity** | 0.317 | -1.861 | 2.496 | 0.009 | 0.775 |
| **SES (Health Literacy)** | -5.066 | -6.006 | -4.127 | -0.324 | **<0.000** |
| **SES (IMD)** | 0.744 | 0.420 | 1.068 | 0.144 | **<0.000** |
| **Clinical Factors** |  |  |  |  |  |
| **Pain Site** | -1.252 | -1.820 | -0.684 | -0.138 | **<0.000** |
| **Comorbidities** | -3.537 | -4.252 | -2.823 | -0.298 | **<0.000** |
| **Duration** | -1.442 | -1.784 | -1.100 | -0.257 | **<0.000** |
| **Previous Surgery** | -7.138 | -9.307 | -4.970 | -0.206 | **<0.000** |
| **Previous Pain Episodes** | -2.795 | -3.237 | -2.353 | -0.370 | **<0.000** |
| **Employment** |  |  |  |  |  |
| **Work Status** | 3.351 | 1.860 | 4.842 | 0.143 | **<0.000** |
| **Work Absence** | -3.485 | -5.686 | -1.285 | -0.141 | **0.002** |
| **Work Absence Duration** | -0.168 | -0.236 | -0.099 | -0.391 | **<0.000** |
| **Function/Disability** |  |  |  |  |  |
| **Pain Intensity** | -1.913 | -2.219 | -1.608 | -0.367 | **<0.000** |
| **MSK-HQ** | 0.665 | 0.605 | 0.724 | 0.577 | **<0.000** |
| **EQ-5D** | 27.421 | 24.713 | 30.129 | 0.544 | **<0.000** |
| **FAB-TSK** | -0.630 | -0.738 | -0.523 | -0.350 | **<0.000** |
| **Distress** | -1.789 | -2.046 | -1.532 | -0.402 | **<0.000** |
| **Self-efficacy** | 0.933 | 0.648 | 1.218 | 0.202 | **<0.000** |
| **Physical Activity** | 0.325 | 0.011 | 0.640 | 0.065 | **0.043** |
| **Social Factors** |  |  |  |  |  |
| **Living Alone** | -4.15 | -6.061 | -2.239 | -0.136 | **<0.000** |
| *Dependent variable; 6-month MSK-HQ score* |

**Table 5: Modified FOTO Backward Stepwise Model: Model summary & coefficients**

|  |  |
| --- | --- |
|   | **Model Summary (N=905)** |
| **Model version** | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | Durbin-Watson |
|   | R Square Change | F Change | df1 | df2 | Sig. F Change |
| a | .665 | 0.442 | 0.436 | 8.719 | 0.442 | 70.946 | 10 | 894 | 0.000 |   |
| b | .665 | 0.442 | 0.437 | 8.714 | 0.000 | 0.003 | 1 | 894 | 0.957 |   |
| c | .665 | 0.442 | 0.437 | 8.709 | 0.000 | 0.01 | 1 | 895 | 0.919 |   |
| d | .665 | 0.442 | 0.438 | 8.706 | 0.000 | 0.35 | 1 | 896 | 0.554 | 1.953 |
| a. Predictors: (Constant), Current paid employment, Pain site, Physical activities, Previous surgery, Sex, Duration of symptoms, Comorbidities, Baseline MSK-HQ score, Previous pain episodes, Age (years) |
| b. Predictors: (Constant), Current paid employment, Pain site, Physical activities, Previous surgery, Duration of symptoms, Comorbidities, Baseline MSK-HQ score, Previous pain episodes, Age (years) |
| c. Predictors: (Constant), Current paid employment, Pain site, Physical activities, Previous surgery, Duration of symptoms, Comorbidities, Baseline MSK-HQ score, Previous pain episodes |
| d. Predictors: (Constant), Current paid employment, Physical activities, Previous surgery, Duration of symptoms, Comorbidities, Baseline MSK-HQ score, Previous pain episodes |
| *Dependent Variable: 6 Months: MSK-HQ score [0 - 56 scale: 0=Worst health; 56=Best health]* |
|  | **Coefficients** |
| **Model version** |   | Unstandardised Coefficients | Standardized Coefficients | t | Sig. | 95.0% Confidence Interval for B |   |
| Beta | Beta | Lower Bound | Upper Bound |
| d | (Constant) | 30.094 |   | 21.481 | 0.000 | 27.344 | 32.843 |
|   | Duration of symptoms | -0.338 | -0.06 | -2.107 | 0.035 | -0.652 | -0.023 |
|   | Physical activities | 2.168 | -0.072 | -2.805 | 0.005 | -0.608 | -0.108 |
|   | Previous surgery | -2.936 | -0.083 | -3.244 | 0.001 | -4.712 | -1.159 |
|   | Baseline MSK-HQ score | -0.358 | 0.489 | 18.157 | 0.000 | 0.502 | 0.623 |
|   | Previous pain episodes | -1.559 | -0.208 | -7.174 | 0.000 | -1.986 | -1.133 |
|   | Comorbidities | -1.601 | -0.134 | -4.979 | 0.000 | -2.232 | -0.97 |
|   | Current paid employment | 0.562 | 0.093 | 3.584 | 0.000 | 0.981 | 3.355 |
|   | *Dependent Variable: 6 Months: MSK-HQ score [0 - 56 scale: 0=Worst health; 56=Best health]* |

**Table 6: NPROMs Backwards Stepwise Model: Model summary & coefficients**

|  |  |
| --- | --- |
|   | **Model Summary (N=896)** |
| **Model version** | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics | Durbin-Watson |
|   | R Square Change | F Change | df1 | df2 | Sig. F Change |
| a | .646 | 0.417 | 0.411 | 8.899 | 0.417 | 63.35 | 10 | 885 | 0.000 |   |
| b | .645 | 0.417 | 0.411 | 8.898 | -0.001 | 0.926 | 1 | 885 | 0.336 |   |
| c | .645 | 0.416 | 0.411 | 8.899 | -0.001 | 1.153 | 1 | 886 | 0.283 |   |
| d | .644 | 0.415 | 0.41 | 8.901 | -0.001 | 1.439 | 1 | 887 | 0.231 |   |
| e | .643 | 0.414 | 0.41 | 8.906 | -0.001 | 1.893 | 1 | 888 | 0.169 | 1.908 |
| a. Predictors: (Constant), Live alone, Pain site, IMD decile, Previous surgery, Sex, Duration of symptoms, Comorbidities, Age (years), Baseline MSK-HQ score, Baseline EQ5D score |
| b. Predictors: (Constant), Live alone, Pain site, Previous surgery, Sex, Duration of symptoms, Comorbidities, Age (years), Baseline MSK-HQ score, Baseline EQ5D score |
| c. Predictors: (Constant), Live alone, Pain site, Previous surgery, Duration of symptoms, Comorbidities, Age (years), Baseline MSK-HQ score, Baseline EQ5D score |
| d. Predictors: (Constant), Live alone, Previous surgery, Duration of symptoms, Comorbidities, Age (years), Baseline MSK-HQ score, Baseline EQ5D score |
| e. Predictors: (Constant), Previous surgery, Duration of symptoms, Comorbidities, Age (years), Baseline MSK-HQ score, Baseline EQ5D score |
| *Dependent Variable: 6 Months: MSK-HQ score [0 - 56 scale: 0=Worst health; 56=Best health]* |
|   | **Coefficients** |
| **Model version** |   |   |   | Unstandardised Coefficients | Standardized Coefficients | t | Sig. | 95.0% Confidence Interval for B |           |
|   |   |   |   | Beta | Beta |   |   | Lower Bound | Upper Bound |
| e | (Constant) | 28.106 |   | 16.27 | 0 | 24.716 | 31.497 |
|   | Age (years) | -0.041 | -0.049 | -1.827 | 0.068 | -0.085 | 0.003 |
|   | Baseline MSK-HQ score | 0.413 | 0.36 | 9.052 | 0 | 0.323 | 0.502 |
|   | Comorbidities | -1.555 | -0.131 | -4.69 | 0 | -2.206 | -0.905 |
|   | Duration | -0.807 | -0.145 | -5.506 | 0 | -1.095 | -0.519 |
|   | Previous surgery | -3.779 | -0.108 | -4.085 | 0 | -5.594 | -1.963 |
|   | Baseline EQ5D score | 9.847 | 0.195 | 4.852 | 0 | 5.863 | 13.831 |
|   | *Dependent Variable: 6 Months: MSK-HQ score [0 - 56 scale: 0=Worst health; 56=Best health]* |

**Table 7: Keele Model 1 Summary: Evidence informed model**

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| --- |
| **Model Summary (N=873)** |
| Model version | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics |   |   |   |   | Durbin-Watson |
|   |   |   |   | R Square Change | F Change | df1 | df2 | Sig. F Change |   |
| a | .598 | 0.357 | 0.355 | 9.276 | 0.357 | 161.074 | 3 | 869 | 0.000 |   |
| b | .646 | 0.417 | 0.411 | 8.863 | 0.059 | 17.585 | 5 | 864 | 0.000 |   |
| c | .647 | 0.419 | 0.412 | 8.860 | 0.002 | 1.184 | 3 | 861 | 0.315 | 1.952 |
| a. Predictors: (Constant), Comorbidities, Age (years), Baseline MSK-HQ score |
| b. Predictors: (Constant), Comorbidities, Age (years), Baseline MSK-HQ score, Previous surgery, IMD decile, Duration of symptoms, Current paid employment, Baseline EQ5D score |
| c. Predictors: (Constant), Comorbidities, Age (years), Baseline MSK-HQ score, Previous surgery, IMD decile, Duration of symptoms, Current paid employment, Baseline EQ5D score, Sex, Pain site, Pain intensity |
| *Dependent Variable: 6 Months: MSK-HQ score [0 - 56 scale: 0=Worst health; 56=Best health]* |

**Table 8: Keele Model 2 Summary: Statistically informed model (forward stepwise model demonstrating additional model strength as variables added)**

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| --- |
| **Model Summary (N=850)** |
| Model version | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics |  |  |  |  | Durbin-Watson |
|  |  |  |  |  | R Square Change | F Change | df1 | df2 | Sig. F Change |  |
| a | .564 | 0.318 | 0.318 | 9.5 | 0.318 | 396.228 | 1 | 848 | 0.000 |  |
| b | .622 | 0.387 | 0.386 | 9.012 | 0.069 | 95.343 | 1 | 847 | 0.000 |  |
| c | .643 | 0.414 | 0.412 | 8.82 | 0.027 | 38.289 | 1 | 846 | 0.000 |  |
| d | .656 | 0.43 | 0.427 | 8.703 | 0.016 | 23.765 | 1 | 845 | 0.000 |  |
| e | .664 | 0.442 | 0.438 | 8.62 | 0.012 | 17.445 | 1 | 844 | 0.000 |  |
| f | .670 | 0.449 | 0.445 | 8.568 | 0.007 | 11.353 | 1 | 843 | 0.001 |  |
| g | .675 | 0.455 | 0.45 | 8.525 | 0.006 | 9.361 | 1 | 842 | 0.002 |  |
| h | .679 | 0.461 | 0.455 | 8.487 | 0.006 | 8.66 | 1 | 841 | 0.003 |  |
| i | .681 | 0.463 | 0.458 | 8.47 | 0.003 | 4.425 | 1 | 840 | 0.036 | 1.927 |
| a Predictors: (Constant), Baseline MSK-HQ score  |
| b Predictors: (Constant), Baseline MSK-HQ score, Previous pain episodes |
| c Predictors: (Constant), Baseline MSK-HQ score, Previous pain episodes, Health Literacy |
| d Predictors: (Constant), Baseline MSK-HQ score, Previous pain episodes, Health Literacy, Comorbidities |
| e Predictors: (Constant), Baseline MSK-HQ score, Previous pain episodes, Health Literacy, Comorbidities, Baseline EQ5D score |
| f Predictors: (Constant), Baseline MSK-HQ score, Previous pain episodes, Health Literacy, Comorbidities, Baseline EQ5D score, Current paid employment |
| g Predictors: (Constant), Baseline MSK-HQ score, Previous pain episodes, Health Literacy, Comorbidities, Baseline EQ5D score, Current paid employment, Previous surgery |
| h Predictors: (Constant), Baseline MSK-HQ score, Previous pain episodes, Health Literacy, Comorbidities, Baseline EQ5D score, Current paid employment, Previous surgery, Physical activities |
| i Predictors: (Constant), Baseline MSK-HQ score, Previous pain episodes, Health Literacy, Comorbidities, Baseline EQ5D score, Current paid employment, Previous surgery, Physical activities, Duration of symptoms |
| *Dependent Variable: 6 Months: MSK-HQ score [0 - 56 scale: 0=Worst health; 56=Best health]* |