**Supplemental Material**

Martinez et al. Distinct trajectories of neuropsychiatric symptoms in the 12 months following traumatic brain injury (TBI): A TRACK-TBI study.

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**eMethods**

***Baseline Growth Model***

The linear growth model fit poorly (see **eTable 2**), especially for 4 symptoms (Depression, Physical, Pain, Sleep). For these dimensions, both piecewise models fit well. For Anxiety and Fear, the overall fit statistics were good for the linear growth model; however, the piecewise models displayed smaller mean residuals, indicating smaller discrepancies at each time point between the factor score mean and the estimated growth trajectory. The overall model fit statistics, the mean residuals, and the plots converged to prefer the piecewise over the linear trajectory. In piecewise model 1, the estimated variance of S2 was small, ranging from 0.003 to 0.006 (i.e., 0.053 - 0.075 standard deviations). Although the overall fit statistics for this model were slightly better than those for piecewise model 2, the statistics for model 2 indicated good fit and mean residuals were no worse than those in model 1. The initial quadratic growth model that allowed for variance of the quadratic growth parameter resulted in very small variance (variance estimates between 0.0000 and 0.0003) of the quadratic growth parameter. Thus, a quadratic growth model with a fixed quadratic parameter was explored. Compared to piecewise linear growth model 2, the quadratic growth models resulted in similar or worse model fit statistics, fewer degrees of freedom for four of the symptoms, and larger mean residuals.

Considering the small variability of S2 in piecewise model 1, model parsimony, and the computational burden for growth mixture models when the base model has an additional variance parameter close to the boundary (and possibly a covariance as well), piecewise model 2 with fixed second slope was selected as the base model for the mixture analysis.

***Selection of Neuropsychiatric Trajectory Models***

The GMMs for each dimension were examined separately to identify the best fitting model (see Table 2). The models with 1 to 5-6 latent classes were considered. Considering the results in **Table 2** and the interpretability of the classified trajectories, the 3-class models were selected for Depression, Anxiety, Fear, Sleep, and Physical.

For Depression, the fit statistics (information criteria, LR tests) preferred the 3-class over the 2-class model. Between 3- and 4-class models, the information criteria statistics preferred the 4-class model, but the LR tests (LVMR and LMR) preferred the 3-class model. Between 4-class and 5-class models, the information criteria statistics did not indicate a clear preference, and the LR tests favored the 5-class model. However, the 4- and 5-class models resulted in a class membership with small proportions, .019 and .001, respectively. The entropy was larger in the 3-class model compared to the 4- and 5- class models.

For Anxiety, the LR tests and entropy preferred the 3-class model, the information criteria statistics were similar or smaller in the 3-class model compared to the 4- and 5-class models, and the 4- and 5-class models resulted in a class membership with small proportions, .021 and .006, respectively.

For Fear, the LR tests preferred the 3-class over the 4-class model. The 5-class model did not show compelling advantage in terms of the information criteria and the LR tests and showed a lower entropy than the 3-class model. The 4- and 5-class models for Fear also suffered the small proportions, .014 and .010, respectively.

For Sleep, the information criteria statistics favored the 3-class over the 2-class model, although the LR tests yielded mixed results. The fit statistics preferred the 4-class over the 3-class model, and the 5-class over the 4-class model. The information criteria statistics showed the same order but by small differences. The entropy was larger in the 3-class than in 4- or 5- class models. The 4- and 5-class models resulted in a class membership with small proportions, .021 and .033, respectively.

For Physical, the information criteria statistics preferred the 3-class over the 2-class model, although the LR tests showed mixed results. No statistic indicated any advantage of using the 4-class over the 3-class model. The fit statistics did not show any compelling advantage of the 5-class model over the 4-class model, but the entropy was larger in the 5-class model. However, the 4- and 5-class solutions suffered extremely small proportions, .008 and .002, respectively.

For Pain, a model with 6 latent classes was also considered. The 5-class model was selected for Pain. The statistics preferred the model with more classes. The LR tests preferred the 4-class over the 3-class, the 5-class over the 4-class, and the 6-class over the 5-class models. The information criteria statistics showed the same order. Among 3- to 6-class models, the entropy was in the same order as well. But the 6-class model resulted in a class membership with a small proportion .011.

**eTable 1**

Model fit statistics for longitudinal measurement invariance models

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Exact fit test | DIFFTESTχ2 (df) | CFI | RMSEA | SRMR |
| Configural | $χ^{2}\left(25121\right)$ = 42123.653 |  | .966 | .016 | .041 |
| Weak | $χ^{2}\left(25274\right)$ = 39275.300 | 286.476 (153) | .972 | .015 | .042 |
| Strong | $χ^{2}\left(25742\right)$ = 39923.902 | 1518.103 (468) | .971 | .015 | .042 |

*Note*. N = 2585. The longitudinal measurement models were estimated using Mplus Linux version 8.2. Models included the following 6 symptom dimensions: Depression, Anxiety, Fear, Sleep, Physical, and Pain. The configural invariance model was identified by (a) setting the loadings for each reference item to be equal across all time points, (b) setting the symptom factor variances to 1 at 2 weeks, (c) setting the first thresholds for each item as equal across all time points, (d) setting the second thresholds for each reference item as equal across all time points, and (e) setting the symptom factor means to zero and variance to one at 2 weeks. p < .001 for both DIFFTEST. χ2 = chi-square statistic; *df* = degrees of freedom; CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean squared residual.

**eTable 2**

Model fit statistics for baseline growth models

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | Exact fit test | CFI | RMSEA | SRMR | AIC | BIC | Mean residual |
| Linear growth model |
| Depression | 511.650 (5) | .919 | .198 | .081 | 57763.595 | 57816.309 | |0.036| - |0.111| |
| Anxiety | 194.702 (5) | .962 | .121 | .045 | 56284.294 | 56336.966 | |0.002| - |-0.127| |
| Fear | 217.076 (5) | .966 | .128 | .048 | 55785.602 | 55838.316 | |0.013| - |0.088| |
| Sleep | 478.924 (5) | .906 | .192 | .084 | 58487.437 | 58540.150 | |0.022| - |0.164| |
| Physical | 1108.416 (5) | .852 | .292 | .125 | 56114.547 | 56167.261 | |0.024| - |0.282| |
| Pain | 1679.827 (5) | .626 | .360 | .183 | 60840.648 | 60893.362 | |0.099| - |0.396| |
| Piecewise linear growth model 1 |
| Depression | 18.193 (3) | .998 | .044 | .010 | 57274.138 | 57338.566 | |-0.001| - |0.001| |
| Anxiety | 57.512 (3) | .989 | .094 | .023 | 56151.104 | 56215.481 | |-0.000| - |0.057| |
| Fear | 3.648 (4)a | 1.000 | .000 | .005 | 55574.175 | 55574.175 | |-0.000| - |0.007| |
| Sleep | 25.614 (3) | .995 | .054 | .015 | 58038.127 | 58102.555 | |0.000| - |0.035| |
| Physical | 36.047 (4) | .996 | .056 | .022 | 55044.178 | 55102.749 | |0.000| - |-0.007| |
| Pain | 27.972 (3) | .994 | .057 | .017 | 59192.794 | 59257.222 | |0.000| - |-0.059| |
| Piecewise linear growth model 2 |
| Depression | 197.667 (5) | .969 | .122 | .037 | 57449.612 | 57502.326 | |-0.000| - |-0.002| |
| Anxiety | 213.527 (5) | .958 | .127 | .034 | 56303.119 | 56355.791 | |-0.000| - |0.047| |
| Fear | 208.024 (5) | .967 | .125 | .035 | 55776.550 | 55829.264 | |-0.000| - |0.005| |
| Sleep | 108.221 (5) | .979 | .089 | .030 | 58116.734 | 58169.447 | |0.000| - |-0.030| |
| Physical | 230.694 (5) | .970 | .132 | .040 | 55236.826 | 55289.540 | |-0.000| - |-0.006| |
| Pain | 151.145 (5) | .967 | .106 | .032 | 59311.967 | 59364.681 | |0.000| - |-0.050| |
| Quadratic growth model |  |  |  |  |  |
| Anxiety | 148.365 (4) | .972 | .114 | .038 | 56235.457 | 56293.982 | |-0.003| - |-0.104| |
| Depression | 322.107 (4) | .949 | .175 | .066 | 57576.052 | 57634.623 | |-0.003| - |-0.070| |
| Fear | 109.621 (4) | .983 | .101 | .035 | 55680.147 | 55738.718 | |-0.001| - |-0.049| |
| Physical | 445.961 (5) | .941 | .185 | .068 | 55452.092 | 55504.806 | |-0.000| - |-0.115| |
| Pain | 410.591 (5) | .909 | .177 | .076 | 59571.413 | 59624.127 | |-0.002| - |-0.166| |
| Sleep | 275.753 (4) | .946 | .162 | .061 | 58286.266 | 58344.837 | |-0.002| - |-0.134| |

*Note*. N = 2572 for Anxiety; N = 2584 for the other symptoms. The degrees of freedom for the exact fit chi-square statistics are shown in parentheses. p < .001 for all exact fit tests, except for a p = .4557. For mean residual, the smallest and the largest mean residuals in magnitude are shown. In Piecewise linear growth model 1 for Fear and Physical, the residual variance at 12 months (T4) was set to zero. In the Quadratic growth model for Physical and Pain, the residual variance at 12 months (T4) was set to zero. CFI = comparative fit index; RMSEA = root mean square error of approximation; SRMR = standardized root mean squared residual; AIC = Akaike’s information criteria; BIC = Bayesian information criteria.

**eTable 3**

Friend control group percentiles of 2-week and 12-month factor mean for each trajectory group

|  |
| --- |
| 2 Weeks│12 Months |
|  | Stable-Low | Worsening | Improving |
| Depression | 64│48 | 68│9157│9447│9174│91 | 97│4796│2898│4296│40 |
| Anxiety | 65│52 |
| Fear | 65│56 |
| Physical | 81│65 |
|  | Stable-Low | Stable-Average | Improving |
| Sleep | 13│27 | 79│65 | 99│28 |
|  | Stable-Low | Worsening | Stable-Average | Improving-Gradually | Improving-Rapidly |
| Pain | 18│13 | 77│86 | 95│86 | 90│43 | 80 │ 21 |

*Note.* Higher percentiles indicate greater symptom burden. For example, the 97th percentile for the 2-week mean of the Depression factor for the Improving group indicates that the group mean at this timepoint was greater than 97% FCs.

**eTable 4.**

Multinomial logistic regressions of trajectory group by injury group controlling for relevant covariates

|  |  |
| --- | --- |
|  | Group (each compared to u-mTBI) |
|  | c-mTBI  | Mod-Sev TBI | OTC | FC |
|  | *Odds Ratio (p value)* |
| Depression  |  |
| Stable-Low > Improving  | **2.01 (.014)** | **3.39 (.010)** | **2.76 (.020)** | **4.94 (.002)** |
| Worsening > Stable-Low  | 1.37 (.111) | **1.85 (.008)** | 1.23 (.430) | 1.48 (.089) |
| Worsening > Improving  | **2.74 (.003)** | **6.28 (<.001)** | **3.39 (.013)** | **7.32 (<.001)** |
| Anxiety  |  |  |  |  |
| Stable-Low > Improving  | 1.74 (.137) | 1.61 (.330) | 4.05 (.056) | 3.09 (.063) |
| Worsening > Stable-Low  | 1.24 (.266) | **2.15 (<.001)** | 1.48 (.092) | **1.77 (.007)** |
| Worsening > Improving  | **2.15 (.061)** | **3.45 (.017)** | **6.00 (.018)** | **5.48 (.007)** |
| Fear |  |  |  |  |
| Stable-Low > Improving  | **2.02 (.031)** | 2.13 (.089) | **6.10 (.013)** | **2.61 (.044)** |
| Worsening > Stable-Low  | 1.13 (.595) | **2.05 (.005)** | **1.90 (.015)** | **3.25 (<.001)** |
| Worsening > Improving  | **2.29 (.034)** | **4.35 (.003)** | **11.61 (.001)** | **8.49 (<.001)** |
| Sleep |  |  |  |  |
| Stable-Low > Improving | **2.15 (.013)** | 1.23 (.636) | 1.96 (.096) | **18.28 (<.001)** |
| Stable-Low > Stable-Average  | 1.08 (.666) | SA > SL 1.68 (.064) | 1.08 (.738) | **2.94 (<.001)** |
| Stable-Average > Improving | **1.99 (.010)** | **2.06 (.039)** | 1.81 (.086) | **6.21 (.002)** |
| Physical  |  |  |  |  |
| Stable-Low > Improving  | **1.93 (.006)** | 1.77 (.065) | **3.77 (.002)** | **5.55 (<.001)** |
| Worsening > Stable-Low  | 0.89 (.666) | **1.98 (.015)** | 1.73 (.062) | **1.95 (.012)** |
| Worsening > Improving  | 1.71 (.128) | **3.51 (.002)** | **6.52 (<.001)** | **10.81 (<.001)** |
| Pain |  |  |  |  |
| Stable-Low > Improving-Rapidly  | 1.06 (.833) | **IR > SL** **3.77 (.015)** | IR > SL 1.96 (.184) | **20.30 (<.001)** |
| Stable-Low > Improving-Gradually  | 1.55 (.127) | IG > SL 2.67 (.080) | IG > SL 2.11 (.143) | **11.48 (<.001)** |
| Stable-Low > Stable-Average  | 1.47 (.130) | SA > SL 2.65 (.069) | SA > SL 2.32 (.082) | **13.74 (<.001)** |
| Stable-Average > Improving-Rapidly  | **IR > SA** **1.39 (.024)** | IR > SA 1.42 (.062) | 1.19 (.382) | 1.48 (.139) |
| Stable-Average > Improving-Gradually  | 1.05 (.780) | IG > SA 1.01 (.975) | 1.10 (.650) | IG > SA 1.20 (.460) |
| Worsening > Stable-Low  | 1.01 (.979) | **4.75 (.006)** | 1.82 (.261) | **SL > W** **3.45 (<.001)** |
| Worsening > Stable-Average  | **1.46 (.037)** | **1.79 (.010)** | SL > W 1.28 (.358) | **3.98 (<.001)** |
| Worsening > Improving-Rapidly  | 1.05 (.805) | 1.26 (.350) | IR > W 1.07 (.816) | **5.89 (<.001)** |
| Worsening > Improving-Gradually  | 1.53 (.055) | **1.77 (.040)** | IG > W 1.16 (.634) | **3.33 (<.001)** |
| Improving-Rapidly > Improving-Gradually  | 1.46 (.051) | 1.41 (.168) | IG > IR 1.08 (.760) | IG > IR 1.77 (.066) |

*Note*. Uncomplicated, mild TBI (u-mTBI) is the reference category for all injury groups. Additional predictors aside from injury group that were included in the model were age, sex, race, education, prior TBI history, and insurance type. The default comparison of likelihood of trajectory class membership is the first class listed (e.g., for Stable-Low > Stable-Average, the odds ratios and p-values indicate greater likelihood of being in the Stable-Low trajectory class relative to the Improving class for a specific symptom dimension) unless otherwise specified within the table (e.g., SA > SL). c-mTBI = complicated, mild traumatic brain injury; Mod-Sev TBI = moderate to severe traumatic brain injury; OTC = orthopedic trauma control; FC = friend control; SA = Stable-Average; SL = Stable-Low; IR = Improving-Rapidly; IG = Improving-Gradually; W = Worsening. Bolded data indicate significant *p* values < .05.

**eFigure 1**

Percentage of persons within each injury subgroup who fell in each Depression trajectory class.

 [insert eFigure1 here]

*Note.* N = 2499. Chi-square test of independence *p* < .001. Red bars denote proportions of group pairs that were significantly different at *p* < .05 in follow-up tests. u-mTBI = uncomplicated, mild traumatic brain injury; c-mTBI = complicated, mild traumatic brain injury; Mod-Sev TBI = moderate to severe traumatic brain injury; OTC = orthopedic trauma control; FC = friend control.

**eFigure 2**

Percentage of persons within each injury subgroup who fell in each Anxiety trajectory class.

 [insert eFigure2 here]

*Note.* N = 2487. Chi-square test of independence *p* < .001. Red bars denote proportions of group pairs that were significantly different at *p* < .05 in follow-up tests. u-mTBI = uncomplicated, mild traumatic brain injury; c-mTBI = complicated, mild traumatic brain injury; Mod-Sev TBI = moderate to severe traumatic brain injury; OTC = orthopedic trauma control; FC = friend control.

**eFigure 3**

Percentage of persons within each injury subgroup who fell in each Fear trajectory class.

 [insert eFigure3 here]

*Note.* N = 2499. Chi-square test of independence *p* < .001. Red bars denote proportions of group pairs that were significantly different at *p* < .05 in follow-up tests.u-mTBI = uncomplicated, mild traumatic brain injury; c-mTBI = complicated, mild traumatic brain injury; Mod-Sev TBI = moderate to severe traumatic brain injury; OTC = orthopedic trauma control; FC = friend control.

**eFigure 4**

Percentage of persons within each injury subgroup who fell in each Sleep trajectory class.

 [insert eFigure4 here]

*Note.* N = 2499. Chi-square test of independence *p* < .001. Red bars denote proportions of group pairs that were significantly different at *p* < .05 in follow-up tests. u-mTBI = uncomplicated, mild traumatic brain injury; c-mTBI = complicated, mild traumatic brain injury; Mod-Sev TBI = moderate to severe traumatic brain injury; OTC = orthopedic trauma control; FC = friend control.

**eFigure 5**

Percentage of persons within each injury subgroup who fell in each Physical trajectory class.

 [insert eFigure5 here]

*Note.* N = 2499. Chi-square test of independence *p* < .001. Red bars denote proportions of group pairs that were significantly different at *p* < .05 in follow-up tests. u-mTBI = uncomplicated, mild traumatic brain injury; c-mTBI = complicated, mild traumatic brain injury; Mod-Sev TBI = moderate to severe traumatic brain injury; OTC = orthopedic trauma control; FC = friend control.

**eFigure 6**

Percentage of persons within each injury subgroup who fell in each Pain trajectory class.

 [insert eFigure6 here]

*Note.* N = 2499. Chi-square test of independence *p* < .001. Red bars denote proportions of group pairs that were significantly different at *p* < .05 in follow-up tests. u-mTBI = uncomplicated, mild traumatic brain injury; c-mTBI = complicated, mild traumatic brain injury; Mod-Sev TBI = moderate to severe traumatic brain injury; OTC = orthopedic trauma control; FC = friend control.