The overall sleep problem prediction results are shown in the following table. Precision, recall, and F-1 scores were calculated based on the average of 10-fold cross validation.

<table>
<thead>
<tr>
<th>Sleep Problem</th>
<th>Class</th>
<th>SVM</th>
<th>RF</th>
</tr>
</thead>
<tbody>
<tr>
<td>No</td>
<td>0</td>
<td>0.68</td>
<td>0.63</td>
</tr>
<tr>
<td>Yes</td>
<td>1</td>
<td>0.73</td>
<td>0.74</td>
</tr>
<tr>
<td>Average*</td>
<td></td>
<td>0.71</td>
<td>0.70</td>
</tr>
<tr>
<td>AUC-ROC Score</td>
<td></td>
<td>0.75±0.13</td>
<td>0.73±0.12</td>
</tr>
</tbody>
</table>

It is important to develop accurate, scalable means for detection of sleep disturbance in this key transitional period of early adolescence. It is possible to capitalize on the ubiquity of smartphones and their data collection capabilities (Millon, 2012) as a means of developing precise, cost-effective ways, to facilitate early screening, and preventative or treatment focused interventions for sleep disturbances in childhood and adolescence (Mohr, Zhang, & Shuelzler, 2017).

### RESULTS

- The results of the current analysis confirm the feasibility and promise of combining the explanatory power of EMA and passive sensing data, paired with ML analytic techniques (cf. Deyer, Falkai, & Koutsoulas, 2018) to predict sleep disturbance in young people.
- Deleterious sleep problems often moderate the development of other common mental health problems in adolescence — a ‘window of vulnerability’ for the development of psychopathology (Nelson et al., 2005).
- Smartphone-based sleep monitoring, coupled with passive sensing, provides an ubiquitous, cost-effective and scalable means (Abdulah et al., 2014) to implement the next generation of mHealth interventions directly at sleep disturbance.

### CONCLUSIONS

- The study used a smartphone application we developed called “eMoodie”.
- Analysis: The current analysis is based on a balanced binary classification task whereby EMA and accelerometer data is combined to predict whether children met the clinical threshold for sleep disturbance based on the well-validated screening measure Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1999). The predictions of Support Vector Machine (SVM) and Random Forest (RF) algorithms were compared. For each prediction, the metrics that were used in experiments were: precision, recall, F-score, ROC-curve and AUC-ROC score.

### CURRENT STUDY & ANALYSIS

- **Aim:** This study is the first (to our knowledge) to report on using ML analyses to evaluate ecological momentary assessment (EMA) data coupled with smartphone sensing for assessing sleep disturbance in a pediatric sample.
- **Sample:** Participants were recruited from three high schools (N=265) in Edinburgh, Scotland. Eligibility was based on age (11-13 years) and access to a smartphone during the study period.
- **App:** The study used a smartphone application we developed called “eMoodie”.
- **Analysis:** The current analysis is based on a balanced binary classification task whereby EMA and accelerometer data is combined to predict whether children met the clinical threshold for sleep disturbance based on the well-validated screening measure Pittsburgh Sleep Quality Index (PSQI; Buysse et al., 1999). The predictions of Support Vector Machine (SVM) and Random Forest (RF) algorithms were compared. For each prediction, the metrics that were used in experiments were: precision, recall, F-score, ROC-curve and AUC-ROC score.

**eMoodie**

- “eMoodie” is a developmentally-informed, EMA app specifically designed for research with children and adolescents.
- It is a cross-platform app deployed on both Android and iOS (Apple) devices. It was created as a research tool for the express purpose of studying mental health, digital technology use, socialization patterns, and other health factors (e.g., physical activity and sleep) in developmental populations.
- eMoodie incorporates gamification features such as the use of pictures in question and answer format to convey the meaning of difficult concepts, and a points feedback system to help engage young participants and improve compliance.
- The app unobtrusively collects sensing data from the device it is installed on, including indices of activity and smartphone usage data.

### REFERENCES

- List of references for further reading.

### DATA SET

- Information for data sets used in this study.

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**eMoodie**

**Www.emoodie.com**

**PREDICTING SLEEP DIFFICULTIES IN EARLY ADOLESCENCE: An ML Analysis Of EMA Data Coupled With Passive Smartphone Sensing Using eMoodie App**

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