**Study Sample and Data Collection**

Our study used a cross-sectional dataset from the Mental Health Million (MHM), an on-going study with the purpose of assessing global mental wellbeing through administration of the MHQ. Initial recruitment targeted the English-speaking population living in the United States, United Kingdom, Canada, South Africa, Singapore, Australia, New Zealand and India, but was later expanded to include Spanish and French speakers as well as other countries for the purpose of capturing a broader global sample. The sample for our present study included 220,324 participants from 214 countries who completed the MHQ from XXX to XXX. Additional information concerning the MHM project and recruitment strategy may be found elsewhere (Newson et al., 2021). This study involved secondary analysis of existing data and there Institutional Research Ethics Board approval was not required.

**Measures:**

**Mental Wellbeing:**

The MHQ is a 47-item voluntary online survey designed to assess a comprehensive range of common attributes found across widely used existing mental health assessment tools in a single questionnaire to estimate overall mental wellbeing and functioning in the population. Items were developed by consolidation of 170 symptoms coded from 126 commonly used psychiatric assessment tools covering depression, anxiety, bipolar disorder, ADHD, post-traumatic stress disorder, obsessive-compulsive disorder, addiction, schizophrenia, eating disorders and autism spectrum disorder. The MHQ is unique from other psychiatric tools in that the items assessed the level of functioning and impact on one’s life associated with each mental health element, as opposed to frequency, duration, or severity of symptoms. The questionnaire took an average of 14 minutes for participants to complete.

Responses were computed into an overall mental wellbeing score, originally ranging from -100 to +200. Recently, the lower limit was expanded to -166 to accommodate a floor effect. Scores are categorized into six levels of functioning, with negative scores indicating clinical risk and positive scores representing normal range: Clinical (≤-50), At Risk (-50 to <0), Enduring (0 to <50), Managing (50 to <100), Succeeding (100 to <150) and Thriving (150 to 200). To compute the overall score, individual item responses were weighted to reflect the nonlinearity of risk associated with increases in symptom severity, as well as the differential risk associated with different symptoms (e.g., suicidal thoughts vs irritability).

In addition to the overall wellbeing score, scores for six broad subcategories of mental wellbeing were computed: Core Cognition (ability for executive functioning), Complex Cognition (reflecting more complex processes such as problem-solving, creativity, and adaptability), Mood and Outlook (ability to effectively regulate ones emotions), Drive and Motivation (ability to achieve goals in the face of obstacles), Social Self (social functioning), and Mind-Body (physical functioning and psychosomatic health). Subcategory scores ranged from -50 to +100, and were computed by a weighted average of scores from 10 to 24 relevant symptom items based on a review of cognitive and brain functioning models (Newson et al., 2020).

The MHQ demonstrated high sample reliability when four randomly selected and demographically similar samples were compared on response distributions (p = 0.99), and resulting MHQ distribution (p = 0.18). Internal consistency was demonstrated with conceptually similar items having higher correlations than unsimilar items. A subset of participants which took the MHQ twice at least 3 days apart showed a test-retest reliability of r = 0.84. Validity was assessed by asking a subset of participants additional questions concerning days missed from work and normal activities in the past month. Those who were employed and scored an overall MHQ between 175 to 200 missed on average 0.2 days of work in the past month, while those employed who scored between -75 to -100 missed an average of 9.3 days of work. (Newson JJ, 2022)

**Physical Activity**: Participants responded to single item that asked: “How regularly do you engage in physical exercise (30 minutes or more)?” Response options included “Rarely/never”; “Less than once a week”; “Once a week”; “Few days a week”; and “Every day.

**Covariates**: To adjust for potential confounders, we selected as covariates age, biological sex, gender identity, ethnicity, educational attainment, employment status, relationship status, frequency of adequate sleep, frequency of socializing, diagnosis of medical condition (Y/N), whether they are currently seeking mental health treatment (Y/N), and whether they have had a significant traumatic childhood or adult experience (Y/N). These variables will be referred to as the full covariate set. All items in which participants responded “Prefer not to say” were recoded as missing for purposes of multiple imputation. Participants were further nested by country in the analysis to account for potential clustering effects. Ethnicity was dropped from further analysis due to high missingness (84.2%) under the assumption that adjusting for country will cover some of the variance explained by ethnicity.

**Statistical Analysis:**

All data preprocessing and statistical analyses were done using the statistical software R (version 4.1.2). As the items used to calculate the overall MHQ score, as well as exercise frequency, were required by the questionnaire, only some covariate items which were not required showed missingness. Answer responses which included “Prefer not to say” were recoded to missing. Missing data was handled with Multiple Imputation using Fully Conditioned Specification as implemented in the R-Package *mice* (van Buuren 2022), with ten imputations. All further analyses were pooled across all imputations.

Covariates were balanced across exercise frequency levels using propensity score weighting as implemented in the R-Package *MatchThem* (Pishgar 2022) to allow for estimation of the Average Treatment Effect on the Treated (ATT) in observational data.

# References

Newson JJ, P. V. (2022). Assessment of Population Well-being With the Mental Health Quotient: Validation Study. *JMIR Ment Health*.