Indirect effect of sleep on abdominal pain through daytime dysfunction in adults with irritable bowel syndrome

Anthony Cifre[1]

[1] University of Houston

Author Note

Add complete departmental affiliations for each author here. Each new line herein must be indented, like this line.

Enter author note here.

The authors made the following contributions. Anthony Cifre: Conceptualization, Writing - Original Draft Preparation, Writing - Review & Editing.

Correspondence concerning this article should be addressed to Anthony Cifre, Postal address. E-mail: my@email.com

Abstract

Study Objectives: Sleep deficiency, psychological distress, daytime dysfunction, and abdominal pain are common in adults with irritable bowel syndrome. Prior research on individuals with chronic pain has identified the indirect effect of sleep on pain through psychological distress or daytime dysfunction; however, this effect is less clear in irritable bowel syndrome. The purpose of this study was to examine potential indirect effects of sleep on abdominal pain symptoms simultaneously through psychological distress and daytime dysfunction in adults with irritable bowel syndrome.

Methods: Daily symptoms of nighttime sleep complaints (sleep quality and refreshment), psychological distress, daytime dysfunction (fatigue, sleepiness, and difficulty concentrating), and abdominal pain were collected in baseline assessments from 2 randomized controlled trials of 332 adults (mean age 42 years and 85% female) with irritable bowel syndrome. Structural equation modeling was used to examine the global relationships among nighttime sleep complaints, psychological distress, daytime dysfunction, and abdominal pain.

Results: The structural equation modeling analyses found a strong indirect effect of poor sleep on abdominal pain via daytime dysfunction but not psychological distress. More than 95% of the total effect of nighttime sleep complaints on abdominal pain was indirect.

Conclusions: These findings suggest that the primary impact of nighttime sleep complaints on abdominal pain is indirect. The indirect effect appears primarily through daytime dysfunction. Such understanding provides a potential avenue to optimize personalized and hybrid behavioral interventions for adults with irritable bowel syndrome through addressing daytime dysfunction and sleep behaviors. Additional study integrating symptoms with biological markers is warranted to explore the underlying mechanisms accounting for these symptoms.

Keywords: irritable bowel syndrome, sleep, pain, daytime dysfunction, psychological

distress

Word count: X

Indirect effect of sleep on abdominal pain through daytime dysfunction in adults with irritable bowel syndrome

Methods

We report how we determined our sample size, all data exclusions (if any), all manipulations, and all measures in the study.

Participants

Material

Procedure

Data analysis

We used R (Version 4.2.2; R Core Team, 2022b) and the R-packages *car* (Version 3.1.1; Fox & Weisberg, 2019; Fox, Weisberg, & Price, 2022), *carData* (Version 3.0.5; Fox et al., 2022), *dplyr* (Version 1.1.0; Wickham, François, Henry, Müller, & Vaughan, 2023), *forcats* (Version 1.0.0; Wickham, 2023), *foreign* (Version 0.8.84; R Core Team, 2022a), *ggplot2* (Version 3.4.1; Wickham, 2016), *ggpubr* (Version 0.6.0; Kassambara, 2023a), *haven* (Version 2.5.1; Wickham, Miller, & Smith, 2022), *lavaan* (Version 0.6.14; Rosseel, 2012), *lme4* (Version 1.1.31; Bates, Mächler, Bolker, & Walker, 2015), *lmerTest* (Version 3.1.3; Kuznetsova, Brockhoff, & Christensen, 2017), *Matrix* (Version 1.5.3; Bates, Maechler, & Jagan, 2022), *pacman* (Version 0.5.1; Rinker & Kurkiewicz, 2018), *papaja* (Version 0.1.1; Aust & Barth, 2022), *purrr* (Version 1.0.1; Wickham & Henry, 2023), *readr* (Version 2.1.4; Wickham, Hester, & Bryan, 2023), *readxl* (Version 1.4.2; Wickham & Bryan, 2023), *rstatix* (Version 0.7.2; Kassambara, 2023b), *stringr* (Version 1.5.0; Wickham, 2022), *tibble* (Version 3.1.8; Müller & Wickham, 2022), *tidyr* (Version 1.3.0; Wickham, Vaughan, & Girlich,

2023), *tidyverse* (Version 1.3.2; Wickham et al., 2019), and *tinylabels* (Version 0.2.3; Barth, 2022) for all our analyses.

Results

Discussion

References

Aust, F., & Barth, M. (2022). *papaja: Prepare reproducible APA journal articles with R Markdown*. Retrieved from https://github.com/crsh/papaja

Barth, M. (2022). *tinylabels: Lightweight variable labels*. Retrieved from https://cran.r-project.org/package=tinylabels

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*(1), 1–48. https://doi.org/10.18637/jss.v067.i01

Bates, D., Maechler, M., & Jagan, M. (2022). *Matrix: Sparse and dense matrix classes and methods*. Retrieved from https://CRAN.R-project.org/package=Matrix

Fox, J., & Weisberg, S. (2019). *An R companion to applied regression* (Third). Thousand Oaks CA: Sage. Retrieved from https://socialsciences.mcmaster.ca/jfox/Books/Companion/

Fox, J., Weisberg, S., & Price, B. (2022). *carData: Companion to applied regression data sets*. Retrieved from https://CRAN.R-project.org/package=carData

Kassambara, A. (2023a). *Ggpubr: 'ggplot2' based publication ready plots*. Retrieved from https://CRAN.R-project.org/package=ggpubr

Kassambara, A. (2023b). *Rstatix: Pipe-friendly framework for basic statistical tests*. Retrieved from https://CRAN.R-project.org/package=rstatix

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2017). lmerTest package: Tests in linear mixed effects models. *Journal of Statistical Software*, *82*(13), 1–26. https://doi.org/10.18637/jss.v082.i13

Müller, K., & Wickham, H. (2022). *Tibble: Simple data frames*. Retrieved from https://CRAN.R-project.org/package=tibble

R Core Team. (2022a). *Foreign: Read data stored by 'minitab', 's', 'SAS', 'SPSS', 'stata', 'systat', 'weka', 'dBase', ...* Retrieved from https://CRAN.R-project.org/package=foreign

R Core Team. (2022b). *R: A language and environment for statistical computing*. Vienna, Austria: R Foundation for Statistical Computing. Retrieved from https://www.R-project.org/

Rinker, T. W., & Kurkiewicz, D. (2018). *pacman: Package management for R*. Buffalo, New York. Retrieved from http://github.com/trinker/pacman

Rosseel, Y. (2012). lavaan: An R package for structural equation modeling. *Journal of Statistical Software*, *48*(2), 1–36. https://doi.org/10.18637/jss.v048.i02

Wickham, H. (2016). *ggplot2: Elegant graphics for data analysis*. Springer-Verlag New York. Retrieved from https://ggplot2.tidyverse.org

Wickham, H. (2022). *Stringr: Simple, consistent wrappers for common string operations*. Retrieved from https://CRAN.R-project.org/package=stringr

Wickham, H. (2023). *Forcats: Tools for working with categorical variables (factors)*. Retrieved from https://CRAN.R-project.org/package=forcats

Wickham, H., Averick, M., Bryan, J., Chang, W., McGowan, L. D., François, R., ... Yutani, H. (2019). Welcome to the tidyverse. *Journal of Open Source Software*, *4*(43), 1686. https://doi.org/10.21105/joss.01686

Wickham, H., & Bryan, J. (2023). *Readxl: Read excel files*. Retrieved from https://CRAN.R-project.org/package=readxl

Wickham, H., François, R., Henry, L., Müller, K., & Vaughan, D. (2023). *Dplyr: A grammar of data manipulation*. Retrieved from https://CRAN.R-project.org/package=dplyr

Wickham, H., & Henry, L. (2023). *Purrr: Functional programming tools*. Retrieved from https://CRAN.R-project.org/package=purrr

Wickham, H., Hester, J., & Bryan, J. (2023). *Readr: Read rectangular text data*. Retrieved from https://CRAN.R-project.org/package=readr

Wickham, H., Miller, E., & Smith, D. (2022). *Haven: Import and export 'SPSS', 'stata' and 'SAS' files*. Retrieved from https://CRAN.R-project.org/package=haven

121 Wickham, H., Vaughan, D., & Girlich, M. (2023). *Tidyr: Tidy messy data*. Retrieved from
122 https://CRAN.R-project.org/package=tidyr