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Brief Report

Person-to-Person Bacterial Transmission Can Change the Sleep Pattern in Newly Married Couples

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Abstract: The composition of the gut microbiota varies significantly among healthy individuals and insomniacs, hypersomniacs and healthy people. On the other hand, there is a substantial bacterial strain shared across these populations with distinct intra-population, mother-to-infant and intra-household transmission patterns. Based on these premises, we propose a hypothesis stating that person-to-person bacterial transmission can change the sleep pattern in couples. In this pilot study, 157 couples who had been married and living together for an average of 5.91 months were enrolled. A wide range of questionnaires were administered to participants to measure sleep patterns. Gut microbiota composition was analyzed at two time points: baseline and 3 months. We found that sleep disturbances in couples can be partially explained by changes in gut microbiota.

Keywords: gut microbiota; bacterial transmission; person-to-person contacts; sleep disturbance

1. Introduction

The metabolic activity, diversity and composition of the gut microbiota vary significantly between healthy individuals and insomniacs [1], and also between hypersomniacs and healthy people [2]. While Clostridiales and Bacteroides are regarded to be the two most important biomarkers for differentiating between healthy people and insomniacs [3], a recent study demonstrated that an enhanced relative abundance of five genera including Lachnospiraceae UCG010, Hungatella, Collinsella, Gordonibacter and Blautia may be correlated with a diminished risk of some types of hypersomnia (narcolepsy type one). Contrarily, an enhanced relative abundance of class Betaproteobacteria, genus Ruminiclostridium and genus Alloprevotella may potentially increase the risk of narcolepsy type one [4].

Here, it worth mentioning a study conducted by Valles-Colomer and colleagues [5]. They detected substantial bacterial strain sharing across people with distinct intra-population, mother-to-infant and intra-household transmission patterns. There was considerable strain sharing among cohabiting people, with 32% and 12% median strain-sharing rates for the time since cohabitation and gut and oral microbiomes affected strain sharing more than genetics or age did.

Based on these premises, we propose a hypothesis:

Person-to-person bacterial transmission can change the sleep pattern in couples.

2. Method

2.1. Participants

Data were drawn from a private sleep clinic, Tehran, Iran. Respondents who had been officially married during the past six months and were in a cohabiting relationship were invited to participate in this study together with their official spouses. One hundred and eighty four heterosexual couples participated in the gut microbiota composition and sleep study. Six couples were excluded because

the women were taking medicines known to affect gut/oral microbiota composition or were pregnant. One hundred and seventy eight participants provided stool samples, of which twenty-one were excluded due to either low readings (n = 10) or missing data (n = 11). The remaining 157 couples were all living with their spouses in a same house. At baseline interview, respondents and their spouses were telephoned on two consecutive days and interviewed separately about their daily experiences, including time use, physical symptoms, mood, and stressful events.

2.2. Sample Collection

Fecal samples were voluntarily collected from participants using the DNA/RNA Shield Fecal Collection Tubes (Zymo Research, Freiburg, Germany). Samples were then transferred to the laboratory and frozen within 15–30 min after collection. All samples were stored at -80°C until further processing. On Day 1 and Day 2, all couples participated in a gut microbiota composition study. Three months later gut microbiota composition was analyzed again with the same protocol. All the respondents participated in the study except one couple who were divorced from each other and had spent significant time living apart. Thirty-two couples were also excluded due to their baseline microbiota resemblance (either insomniac or hypersomniac phenotype) to avoid overlap bias. Data drawn from 152 couples were analyzed.

2.3. Sleep Study

The participants voluntarily completed the validated Persian versions of Pittsburgh Sleep Quality Inventory (PSQI), Epworth Sleepiness Scale (ESS), Insomnia Severity Index (ISI), and global sleep assessment questionnaire (GSAQ) [6]. Insomnia was defined as coexistence of both daytime dysfunction and difficulty resuming sleep [7]. Hypersomnia was defined by a bed-rest total sleep time ≥ 19 hour during the 32-hour recording [8]. SPSS ver.16 was used to analyze the data.

3. Results

This is an interim result and the detailed results will be published in full in a peer-reviewed journal and will be disseminated. Men had an average age of 37.20 years, with a standard deviation (SD) of 8.01, and 84.3% had attained a college degree. Women had an average age of 31.02 years (SD = 9.30), and 87.2% had attained a college degree. All participants were Iranian (ethnicities including: 83 Persian, 69 Azeri, and 5 Arab). The couples had been married and living together for an average of 5.91 months (SD = 2.03).

Briefly, gut microbiota composition in participants with normal sleep pattern were significantly changed and becomes similar to that of participant's spouse, i.e. if the spouse was insomniac or hypersomniac, then gut composition becomes similar to his/her insomniac or hypersomniac spouse, respectively. Interestingly, in support of our hypothesis, similar and parallel changes were observed in sleep pattern of subjects with normal sleep pattern. Women/men with a normal sleep pattern, who had married with a hypersomniac or insomniac spouse, reported a disturbance in their normal sleep pattern. Table 1 demonstrates results of the chi square test. Statistical analyses with an array of sleep questionnaires including the PSQI, ESS, ISI and GSAQ confirmed the report. Results remained significant after controlling for confounders. The formal mediation analysis confirmed the results (data not shown due to editorial limits of the paper).

Three months after the marriage, spouses with healthy sleep pattern were significantly more likely to resemble their insomniac or hypersomniac couples.

Table 1. Distribution of study participants according to gender, gut microbiota composition and sleep pattern.

	Sleep pattern		
Gender	Healthy Sleep Pattern	Insomniac Pattern	Hypersomniac Pattern

Men	<p><i>Baseline</i>€: 28 (28.28) [0.00]</p> <p><i>GMT</i>* Normal</p>	<p>26 (24.07) [0.16]</p> <p><i>GMT</i>: Insomniacs had significantly decreased family Ruminococcaceae, family Bacteroidaceae, and genus Bacteroides, along with significantly increased family Prevotellaceae and genus Prevotella, compared with healthy participants. Genus Fusicatenibacter and genus Gemmiger were dominant in insomniacs, while genus Clostridium XI, genus Oscillibacter, genus Coprococcus, and family Peptostreptococcaceae were dominant in healthy participants.</p>	<p>20 (21.66) [0.13]</p> <p><i>GMT</i>: Hypersomnics had significantly increased relative abundance of class Betaproteobacteria, genus Ruminiclostridium6 and genus Alloprevotella.</p>
	<p><i>Three months later</i> £: 7 (13.38) [3.04]</p> <p><i>GMT</i>: Normal</p>	<p><i>Three months later</i> 83 (71.56) [1.83]</p> <p><i>GMT</i>: As above</p>	<p><i>Three months later</i>: 15 (20.06) [1.28]</p> <p><i>GMT</i>: As above</p>
Women	<p><i>Baseline</i>: 19 (18.72) [0.00]</p> <p><i>GMT</i>: Normal</p>	<p>14 (15.93) [0.23]</p> <p><i>GMT</i>: As above</p>	<p>16 (14.34) [0.19]</p> <p><i>GMT</i>: As above</p>
	<p><i>Three months later</i> 13 (6.62) [6.14]</p> <p><i>GMT</i>: Normal</p>	<p><i>Three months later</i> 24 (35.44) [3.69]</p> <p><i>GMT</i>: As above</p>	<p><i>Three months later</i>: 15 (9.94) [2.58]</p> <p><i>GMT</i>: As above</p>

*GMT: Gut microbiota composition. € At baseline, there were no significant differences among three groups for gut microbiota composition, sex and sleep pattern. £ Three months after the marriage, there were significant differences in terms of gut microbiota composition and sleep pattern. Individuals who were married with a

hypersomniac or an insomniac spouse were more likely to become hypersomniac or insomniac after 3 months ($p < 0.0001$). These changes were parallel to the gut microbiota composition ($p < 0.0001$).

4. Discussion

We found that sleep disturbances in couples can be partially explained by changes in gut microbiota. Many types of physiologic synchrony have been reported between couples before, for instance, synchrony of diurnal cortisol pattern [9], cardiac synchrony [10] and also sleep concordance [11], just to mention a few among many. To the best of author's knowledge, this is the first study showing that sleep disturbances can be mediated via spouse's gut microbiota transamination, particularly in such a short term, i.e., about almost 6 months after marriage. Previous studies have highlighted the substantial role of affective experience in regulation of sleep through behaviors such as touching, and "sleep-touch" among couples [12]. Most definitely, socioeconomic status [13], couples' sleep and psychological distress [14] can also significantly change the sleep pattern in couples. It is also known that anxiety can partially predict dyadic sleep characteristics in couples experiencing insomnia but not in couples without sleep disorders [15]. There are obviously many other confounding factors at play in the pathophysiology of sleep disturbances. Note that this study is ongoing and further analysis will reveal the mechanism behind this novel and exciting finding. Figure 1 depicts a simplified model showing how bacterial transmission between couples may change the sleep pattern.

5. Conclusion

We provide evidence of gut microbial community structure alterations in newly married couples which parallels with reduced sleep quantity and quality. However, further larger and longitudinal multiomics studies are required to replicate and elucidate the relationship between the gut microbiota and sleep disturbances in newly married couples.

Authors' Contributions: RR and FM wrote the manuscript. RR critically reviewed the manuscript. All authors approved the final version of the manuscript.

Data Availability: The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

Informed Consent and Ethics Approval: All the participants were assured of confidentiality of their personal details and that the information obtained will be only used for research purposes and their profile will be kept confidential during the research and thereafter. We did this study in a private sleep clinic and all the participants expressed their informed consent to participate in the voluntarily research. Written informed consent was obtained from all study participants. Ethical approval was obtained from the Human Research Ethics Committee (IT. 24001670). We adhered to the tenets of the Declaration of Helsinki.

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Conflict of Interest: The authors declare no conflict of interest.

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