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Original Article

Laxatives are Associated with Poorer Polysomnography-derived Sleep Quality

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ABSTRACT: ***Objective:*** To characterize 1) the relationship between laxative use and objective sleep metrics, and 2) the relationship between laxative use and self-reported insomnia symptoms in a convenience sample of middle-aged/elderly patients who completed in-laboratory polysomnography. ***Methods:*** We cross-sectionally analyzed first-night diagnostic in-laboratory polysomnography data for 2946 patients over the age of 40 (mean age 60.5 years; 48.3% male). Laxative use and medical comorbidities were obtained through self-reported questionnaires. Patient insomnia symptoms were based on self-report. Associations between laxative use and objective sleep continuity were analyzed using multivariable linear regression models. Associations between laxative use and insomnia were assessed using multivariable logistic regression models. ***Results:*** After adjusting for age, sex, body mass index, total recording time, and relevant comorbidities, laxative users had a 7.1% lower sleep efficiency ($p < 0.001$), 25.5-minute higher wake after sleep onset ($p < 0.001$), and a 29.4-minute lower total sleep time ($p < 0.001$) than patients not using laxatives. Laxative users were found to be at greater odds of reporting insomnia symptoms (OR = 1.7, $p = 0.024$) than patients not using laxatives. ***Conclusion:*** Laxative use is associated with impairments in objective sleep continuity. Patients using laxatives were also at greater odds of reporting insomnia symptoms.

RÉSUMÉ : Les laxatifs : associés à une mauvaise qualité de sommeil observée à la polysomnographie. ***Objectif :*** L'étude visait à caractériser : 1) la relation entre l'usage des laxatifs et les mesures objectives de sommeil; 2) la relation entre l'usage des laxatifs et les symptômes d'insomnie déclarés par les sujets, dans un échantillon de commodité composé de patients d'âge mûr ou avancé, qui ont participé à une étude sur le sommeil par polysomnographie en laboratoire. ***Méthode :*** Il s'agit d'une analyse transversale de données recueillies par polysomnographie de diagnostic de première nuit, réalisée en laboratoire, chez 2946 patients âgés de plus de 40 ans (âge moyen : 60,5 ans; hommes : 48,3 %). Les renseignements sur l'usage des laxatifs et les maladies concomitantes ont été obtenus à l'aide de questionnaires remplis par les sujets. Les symptômes d'insomnie étaient également déclarés par les patients. Les associations entre l'usage des laxatifs et la continuité objective du sommeil ont été analysés à l'aide de modèles de régression linéaire multivariée. Quant aux associations entre l'usage des laxatifs et l'insomnie, elles ont été évaluées à l'aide de modèles de régression logistique multivariée. ***Résultats :*** Les données ont révélé, après rajustement des données pour tenir compte de l'âge, du sexe, de l'indice de masse corporelle, du temps total d'enregistrement et des maladies concomitantes pertinentes, que les utilisateurs de laxatifs connaissaient une diminution de l'efficacité du sommeil de 7,1 % ($p < 0,001$), un prolongement des périodes d'éveil de 25,5 minutes après l'endormissement ($p < 0,001$) et une réduction du temps total de sommeil de 29,4 minutes ($p < 0,001$) comparativement au non-utilisateurs de laxatifs. Les premiers étaient donc plus susceptibles de déclarer des symptômes d'insomnie (risque relatif approché = 1,7; $p = 0,024$) que les seconds. ***Conclusion :*** L'usage des laxatifs est associé à des troubles de la continuité objective du sommeil. Les patients qui faisaient usage de laxatifs étaient également plus susceptibles d'éprouver des symptômes d'insomnie.

Keywords: Insomnia; Sleep quality; Constipation; Laxative; Polysomnography

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Introduction

Chronic constipation is a common gastrointestinal disorder affecting 16% of adults with direct medical costs over $230 million annually[1] in addition to lost earnings from reduced work productivity.[2] Criteria for chronic constipation include the presence of fewer than three bowel movements per week, the strained passage of bowel movements, and/or lumpy or hard stools in over a quarter of defecations in the past 3 months.[3] Untreated chronic constipation, particularly in the middle-aged and elderly,[4] can result in bowel

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Table 1: Observational studies on constipation and sleep quality

First author, year	Study type	Sample size	Mean age (SD)*	Study arms	Sleep evaluation	Constipation evaluation	Main outcome
Cremonini, 2009	Cross-sectional	3228	52.7 (0.3)	Sleep disturbance (874) vs healthy sleep (2354)	Insomnia Severity Index	Talley Bowel Disease Questionnaire, Likert Scale	↑Wake >1 per night ↑Trouble staying asleep
Ueki, 2011	Cross-sectional	344	70.5 (median)	Constipation/laxative use (161) vs non-constipation (183)	Athens Insomnia Scale	Self-report	↑Insomnia prevalence
Cañete, 2015	Cross-sectional	424	73.5 (7.5)	Constipation (145) vs normal (215) vs diarrhea (64)	Pittsburgh Sleep Quality Index (PSQI)	Bristol Stool Form Scale (BSFS)	↑Difficulty falling asleep ↑Total sleep
Bouchoucha, 2018	Cross-sectional	1009	48.5 (16.5)	Constipation (493) vs other functional gastrointestinal disorders (516)	Sleep Quality Scale: drowsiness to insomnia	Rome III, BSFS	↑Constipation prevalence in severe insomnia patients
Chen, 2020	Cross-sectional	360	36.6 (9.4)	Functional constipation (54) vs constipation predominant IBS (23) vs non-constipation (283)	PSQI	Rome III, Gastrointestinal Symptom Rating Scale	↓Sleep quality
Adejumo, 2020	Cross-sectional	14,590	≥20	Normal (7–8 hours) vs short (<7 hours) vs long (>8 hours) sleep duration	Sleep Duration Survey	BSFS, National Health and Nutrition Examination Survey	↑Constipation odds with <7 hours of sleep
Shapiro, 2021	Prospective, virtual (16 weeks)	756	36.6 (10.0)	Within participants: regular days vs irregular (constipated) days	Fitbit device	Self-report	↓Total sleep

*Unless otherwise specified.

obstruction, stercoral ulcers, fecal impaction, and anal fissures.[5] For these reasons, 72% of patients with chronic constipation use laxatives of various types to relieve their symptoms.[6,7] Research has also suggested that constipation affects sleep[8] and may be associated with functional impairment and reduced quality of life as a consequence of sleep disruption.[9–11]

Prior literature has demonstrated that constipation may be associated with poorer sleep continuity. Constipation was linked to difficulty falling asleep,[12] changes in total sleep time,[13–16] and overall reduced sleep quality[17] (Table 1). However, these observational studies, except for one,[16] relied on subjective questionnaires to assess sleep continuity in constipated patients. Past studies have also indicated that constipation may be linked with insomnia. Constipation was associated with waking up more than once a night[18] and greater insomnia severity.[13,14] Table 1 provides an overview of prior studies that have examined the relationship between sleep continuity (or insomnia) and constipation.[12–18]

While subjective reports of sleep continuity and insomnia have been linked to the presence of constipation particularly in the middle-aged and elderly, the impact of constipation on objective metrics of sleep continuity has remained underexplored. Thus, the primary purpose of this study was to investigate the association of laxative use and laxative subtypes (markers of constipation) on objective markers of sleep continuity in a middle-aged/elderly population (≥40 years old). Secondarily, we aimed to explore whether laxative use was associated with self-reported insomnia symptoms.

Methods

Ethics

This study was approved by the Sunnybrook Research Ethics Board (Study ID 3095: Examining the link between clinical and physiological sleep data and health-related outcomes) for a cross-sectional retrospective analysis of the polysomnographic and clinical data examined in this study.

Study Population and Measures

We collected the sleep and medication data of all patients who completed diagnostic overnight polysomnography at Sunnybrook Health Sciences Centre between 2010 and 2015. Level I, technologist-monitored in-hospital polysomnography (Compumedics Neuroscan, Australia) was performed as previously described[19] and scored according to the 2007 American Academy of Sleep Medicine criteria.[20] The presence of self-reported insomnia was obtained through a sleep history questionnaire with the following question: "1. Do you have any of the following medical issues? Check all that apply" (insomnia is one of the options). Sleep-related outcomes of interest included sleep onset latency (SOL: time from full wakefulness to sleep onset), sleep efficiency (SE: proportion of total time in bed spent asleep), wake time after sleep onset (WASO: length of periods of wakefulness occurring after sleep onset), total sleep time (TST), and arousal index (AI: number of arousals per hour), as previously described[21]. Demographic information and medical comorbidities were obtained from questionnaires filled out by patients during the night of their sleep study. Medication logs were collected by a sleep technologist on the night of the sleep study. A graduate student (YSC) subsequently coded medications to identify patients using laxatives of all types including stool softeners, osmotic laxatives, and stimulant laxatives. Laxative use was considered a proxy for chronic constipation since upwards of 72% of patients with chronic constipation use them as treatment.[6,7]

Risk Factors and Confounders

As observed in previous studies,[22–24] age, sex, and body mass index (BMI) were chosen for inclusion as adjustable variables in

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Table 2: Clinical characteristics of the study population according to the use of laxatives

	Total (N = 2946)	Laxative non-user (N = 2843)	Laxative user (all types) (N = 103)	*p*-Value
Demographic Variables				
Age, mean (SD)	60.5 (12.0)	60.1 (11.8)	71.6 (10.6)	<0.001[a]
Male, N (% male)	1422 (48.3%)	1374 (48.3%)	48 (46.6%)	0.81[b]
Body Mass Index, mean (SD)	29.2 (6.57)	29.2 (6.58)	28.5 (6.31)	0.26[a]
Diabetes (N = 2944), N (%)	442 (15.0%)	411 (14.5%)	31 (30.1%)	<0.001[b]
Stroke (N = 2944), N (%)	340 (11.5%)	319 (11.2%)	21 (20.4%)	0.007[b]
Parkinson's Disease (N = 2945), N (%)	114 (3.9%)	106 (2.9%)	12 (11.7%)	<0.001[b]
Opioids, N (%)	198 (6.7%)	179 (6.3%)	19 (18.4%)	<0.001[b]
Insomnia Symptoms (N = 2945), N (%)	597 (20.3%)	566 (19.9%)	31 (30.1%)	0.016[b]
Polysomnography-Derived Variables				
Total Recording Time (min), mean (SD)	413 (42.2)	414 (42.2)	411 (43.3)	0.63[a]
Total Sleep Time (min), mean (SD)	289 (80.7)	291 (80.1)	229 (73.8)	<0.001[a]
Sleep Efficiency (%), mean (SD)	69.9 (18.0)	70.4 (17.8)	55.7 (17.3)	<0.001[a]
Sleep Onset Latency (min), mean (SD)	23.6 (29.1)	23.2 (28.4)	34.2 (43.1)	<0.001[a]
Wake After Sleep Onset (min), mean (SD)	100 (64.7)	98.7 (63.9)	148 (69.7)	<0.001[a]
Arousal Index, mean (SD)	23.6 (17.0)	23.6 (16.9)	25.5 (18.8)	0.25[a]
Apnea-Hypopnea Index, mean (SD)	13.9 (19.8)	13.8 (19.7)	16.7 (20.5)	0.13[a]
Lowest O_2 desaturation (%), mean (SD)	84.6 (8.85)	84.7 (8.77)	82.6 (10.5)	0.018 [a]
Periodic Limb Movement Index, mean (SD)	15.4 (28.2)	14.9 (27.6)	27.5 (38.7)	<0.001[a]
Duration in Non-REM Stage 1 (min), mean (SD)	61.5 (39.8)	61.5 (39.9)	60.4 (36.1)	0.78[a]
Duration in Non-REM Stage 2 (min), mean (SD)	150 (58.2)	151 (57.9)	122 (57.9)	<0.001[a]
Duration in Non-REM Stage 3 (min), mean (SD)	35.5 (32.1)	35.9 (32.2)	23.0 (28.3)	<0.001[a]
Duration in REM (min), mean (SD)	42.4 (28.3)	43.1 (28.3)	23.3 (21.8)	<0.001[a]

N = 2946, unless otherwise specified
REM: Rapid eye movement.
[a]Student's t-test.
[b]Chi-square test.

regression analyses due to their impact on constipation and independent association with sleep continuity[21]. A literature review was conducted to identify relevant co-morbidities with a significant relationship with chronic constipation from at least one published study; these included stroke,[22,25] diabetes,[22,26] Parkinson's Disease,[22,27,] and use of opioids.[28,29]

Statistical Analyses

For our descriptive statistics, frequency counts were computed for categorical variables. Means and standard deviations (SDs) were calculated for normally distributed continuous variables. For non-normally distributed continuous variables and ordinal data, we calculated the median and interquartile range.

To explore the relationship between laxative use and various objective sleep metrics (TST, SE, SOL, WASO, and AI), we constructed multivariable linear regression models. In the first minimally adjusted models, demographic variables such as age, sex, BMI, and laxative use (all types, stool softener, osmotic, or stimulant) were included in our analyses. In the second fully adjusted models, we included age, sex, BMI, and laxative use as well as clinically relevant comorbidities such as prior stroke, diabetes, Parkinson's Disease, and opioid use. All variables were assessed for multi-collinearity (defined as a variance inflation factor > 2.5) before the construction of each model.[30] All fully adjusted models controlled for the effect of total recording time due to its influence on sleep continuity variables.[31] To relax the assumption of linearity, all continuous variables were modeled as restricted cubic splines with three knots.[32] As recommended, knots were placed at the 10th, 50th, and 90th percentiles of each predictor.[32] Homoscedasticity was visually assessed using the residuals versus fitted values plot. Normality was visually assessed using a residual Q-Q plot; however, no outcome transformations were applied as such transformations can bias model estimates, and models constructed with a large sample size (i.e. where the number of observations per parameter is >10) are generally robust to the normality assumption.[33]

In our secondary analyses, multivariable logistic regression models were used to explore the relationship between laxative use and insomnia. The first minimally adjusted models included the variables of age, sex, BMI as well as laxative use (all types, stool softener, osmotic, or stimulant). The second fully adjusted models included the variables of prior stroke, diabetes, Parkinson's Disease, and opioid use in addition to age, sex, BMI, and laxative use. In addition, all fully adjusted models controlled for the effect of total recording time due to its influence on markers of sleep

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Table 3: Linear regression models examining the association between laxatives (and subtypes) and sleep metrics while controlling for the impact of various covariates

	Minimally adjusted				Fully adjusted			
Variables	β	CI (95%)	R^2	*p*-Value	β	CI (95%)	R^2	*p*-Value
Laxative (All types)								
SE	−7.96	−11.29 to −4.64	0.170	**<0.001**	−7.08	−10.42 to −3.73	0.177	**<0.001**
SOL	5.21	−0.56 to 10.98	0.037	0.077	4.26	−1.54 to 10.06	0.046	0.150
WASO	26.95	15.03 to 38.88	0.174	**<0.001**	25.50	13.65 to 37.35	0.201	**<0.001**
TST	−35.72	−50.81 to −20.62	0.150	**<0.001**	−29.38	−43.26 to −15.50	0.295	**<0.001**
AI	0.62	−2.66 to 3.90	0.091	0.712	0.82	−2.47 to 4.12	0.100	0.624
Stool Softeners								
SE	−7.73	−11.89 to −3.57	0.168	**<0.001**	−6.89	−11.07 to −2.71	0.175	**0.001**
SOL	3.99	−3.22 to 11.20	0.036	0.278	3.01	−4.22 to 10.23	0.045	0.415
WASO	27.28	12.37 to 42.20	0.172	**<0.001**	26.27	11.48 to 41.05	0.199	**0.001**
TST	−35.49	−54.37 to −16.61	0.147	**<0.001**	−28.80	−46.12 to −11.48	0.293	**<0.001**
AI	0.96	−3.14 to 5.05	0.091	0.647	1.09	−3.02 to 5.20	0.100	0.602
Osmotic Laxatives								
SE	−7.32	−15.23 to 0.59	0.165	0.070	−6.70	−14.60 to 1.20	0.173	0.097
SOL	11.24	−2.42 to 24.91	0.037	0.107	9.47	−4.18 to 23.13	0.046	0.174
WASO	28.52	0.19 to 56.85	0.169	**0.049**	20.32	−7.66 to 48.30	0.196	0.155
TST	−16.48	−52.36 to 19.41	0.144	0.368	−29.42	−62.18 to 3.34	0.292	0.079
AI	1.32	−6.45 to 9.09	0.091	0.739	2.08	−5.68 to 9.84	0.100	0.599
Stimulant Laxatives								
SE	−6.82	−11.77 to −1.87	0.191	**0.007**	−5.74	−10.70 to −0.79	0.197	**0.023**
SOL	5.66	−2.90 to 14.22	0.166	0.036	5.04	−3.52 to 13.60	0.046	0.249
WASO	18.34	0.61 to 36.08	0.170	**0.043**	18.26	0.73 to 35.79	0.197	**0.041**
TST	−35.44	−57.87 to −13.01	0.146	**0.002**	−23.18	−43.72 to −2.65	0.292	**0.027**
AI	−3.99	−8.85 to 0.87	0.092	0.108	−3.86	−8.73 to 1.00	0.101	0.119

In our minimally adjusted model, covariates were age, sex, BMI, and laxative use. In our fully adjusted model, covariates were age, sex, BMI, diabetes, stroke, Parkinson's Disease, opioid use, total recording time, and laxative use. ***p* < 0.05 (bolded)**.

continuity.[31] All continuous variables were modeled as restricted cubic splines with three knots placed at the 10th, 50th, and 90th percentiles of each predictor.[32]

In addition, we performed a post hoc sensitivity analysis excluding patients using multiple types of laxatives using multivariable linear regression models (detailed methods and results are available in the supplementary data).

Statistical significance was set to $p < 0.05$. All data analyses were performed in R (version 3.6.1) using the "rms" package. Model validation was performed using the "0.632 Bootstrap" method to assess the overfitting of the models.

Results

Study Population

A flowchart of the study population is shown in Figure 1. In this study, we cross-sectionally evaluated 2946 patients who completed diagnostic in-laboratory polysomnography (mean age = 60.5 ± 12.0 years; 48.3% male). The use of laxative medication of any type was reported by 3.5% of patients (103/2946; mean age = 71.6 ± 10.6 years; 46.6% male). Of all 103 patients using laxatives, 64 patients were using stool softeners, 17 were using osmotic laxatives,

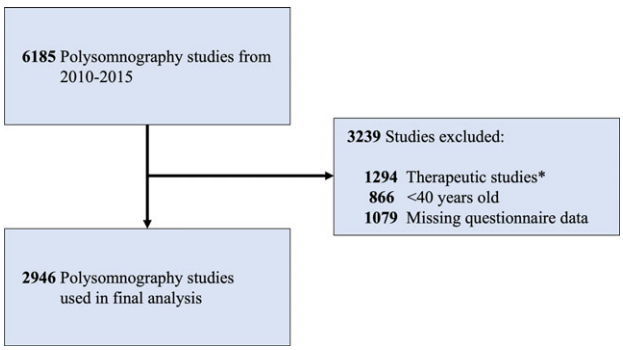

Figure 1: Flowchart of the study population. *Therapeutic studies included continuous or bilevel positive or expiratory airway pressure titrations, split-night studies, and adaptive servo-ventilation studies.

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Table 4: Logistic regression analyses on the impact of laxatives and subtypes on insomnia symptoms controlling for the impact of various covariates

	Minimally adjusted			Fully adjusted		
Variables	OR and CI (95%)	R^2	*p*-Value	OR and CI (95%)	R^2	*p*-Value
Laxative (All types)	1.83 (1.16–2.88)	0.046	**0.009**	1.70 (1.07–2.68)	0.059	**0.024**
Stool Softeners	1.01 (0.54–1.90)	0.042	0.975	0.91 (0.48–1.73)	0.057	0.775
Osmotic Laxative	2.08 (0.74–5.83)	0.043	0.162	2.25 (0.80–6.34)	0.058	0.123
Stimulant Laxative	2.73 (1.45–5.16)	0.047	**0.002**	2.46 (1.30–4.67)	0.060	**0.006**

In our minimally adjusted model, covariates were age, sex, and BMI. In our fully adjusted model, covariates were age, sex, BMI, diabetes, stroke, Parkinson's Disease, and opioid use. **$p < 0.05$ (bolded).**

and 45 were using stimulant laxatives (23 patients were using multiple laxative types). Insomnia was reported in 597 patients (20.3% of total sample); 31 patients reporting insomnia were also using laxatives (30.1%; 13 stool softener users, 6 osmotic laxative users, 17 stimulant laxative users, and 5 using multiple laxatives concurrently). The clinical characteristics of the study population are reported in Table 2.

Linear Regression Analysis: Laxative Use and Objective Sleep Metrics

In our fully adjusted model, laxative users (all types) had 7.1% lower sleep efficiency ($p < 0.001$), 25.5-minute greater wake after sleep onset ($p < 0.001$), and 29.4-minute lower total sleep time ($p < 0.001$) than non-laxative users. Stool softener users had 6.9% lower sleep efficiency ($p = 0.001$), 26.3-minute greater wake after sleep onset ($p = 0.001$), and 28.8-minute lower total sleep time ($p < 0.001$) than those not using stool softeners. Stimulant laxative users had 5.7% lower sleep efficiency ($p = 0.023$), 18.3-minute greater wake after sleep onset ($p = 0.041$), and 23.2-minute lower total sleep time ($p = 0.027$) than those not using stimulant laxatives. Osmotic laxative use was not significantly associated with changes in sleep metrics in our fully adjusted models. Similar results were also seen in our minimally adjusted models (Table 3).

Logistic Regression Analysis: Laxative Users and Insomnia Symptoms

In both our minimally and fully adjusted models, laxative users (of all types) ($p = 0.024$) and stimulant laxative users ($p = 0.006$) were at greater odds of reporting insomnia symptoms than non-laxative users. Stool softener and osmotic laxative users had no statistically significant association with insomnia symptoms (Table 4).

Discussion

The main purpose of this study was to ascertain any changes in objective sleep metrics (obtained through in-laboratory polysomnography) with laxative use and to secondarily assess the association of laxative use with self-reported insomnia symptoms in a population over 40 years of age. In both our minimally and fully adjusted models, the use of laxative subtypes was significantly associated with worse sleep continuity, specifically with lower sleep efficiency and total sleep time, as well as greater wake after sleep onset. In addition, in both our minimally and fully adjusted models, laxative users (all types) and stimulant laxative users were at significantly greater odds of reporting the presence of insomnia symptoms.

Our study was unique because we used objective sleep metrics to assess sleep continuity in a relatively large study population compared to prior research. Laxative users (all types), stool softener users, and stimulant laxative users were found to have significantly worse objective sleep continuity in both our minimally and fully adjusted linear regression models. Using laxative use as a proxy for constipation, our results align with past research. Cremonini et al demonstrated that reported trouble staying asleep was more likely in the presence of constipation in a sample of middle-aged adults.[18] Cañete et al demonstrated that elderly patients with constipation had greater difficulty falling asleep and reported changes in total sleep time relative to healthy patients.[12] Adejumo et al. found increased odds of constipation given shortened sleep duration (<7 hours) based on health surveys.[15] Similarly, Shapiro et al. demonstrated that there was reduced total sleep time on constipated days relative to normal days based on Fitbit data in a middle-aged population.[16] Majority of these studies relied on self-reported constipation in contrast to ours which relied on inferred constipation based on laxative use.

In our logistic regression analyses, users of all laxative types and users of stimulant laxatives were found to have greater odds of reporting insomnia symptoms than non-users, and this finding persisted with our fully adjusted model. Similarly, past research has indicated an association between insomnia and constipation. Using the Pittsburgh Sleep Quality Index (PSQI), Chen et al demonstrated that constipation was independently associated with poor overall sleep quality (PSQI > 5) in a sample of middle-aged patients.[17] Cremonini et al, using questions from the Insomnia Severity Index, demonstrated that waking up more than once a night was more likely in the presence of constipation in middle-aged adults.[18] Bouchoucha et al. demonstrated that middle-aged patients with self-reported severe insomnia (waking up 1-2 hours early and unable to return to sleep) had a significantly greater prevalence of constipation.[13] A similar result was obtained by Ueki et al. using the Athens Insomnia Scale, as elderly patients with constipation had significantly higher scores than healthy patients.[14] Furthermore, since SE, WASO, and TST were affected by laxative use but not SOL or AI, this may imply that constipation or laxative use is associated with sleep maintenance rather than sleep-onset insomnia.

Laxatives are a widely used treatment for chronic constipation[6,7] particularly when diet changes such as increased fiber intake or bulk-forming agents are insufficient.[34] Laxative classes have different mechanisms of action and varying degrees of effectiveness. Stool softeners, for example, are considered emollient laxatives which reduce the surface tension of the stool attracting water to soften them.[35] Severe side effects with stool softener use are uncommon.[35] Osmotic laxatives draw water into the bowels to help treat constipation symptoms[36,37]; however, prescribed medications of this class such as Linaclotide can have more severe side effects. The United States Food and Drug Administration (FDA) issued a black box label for the prescription of Linaclotide due to the risk of severe dehydration.[38] Lastly, stimulant laxatives treat more severe constipation by stimulating the colonic musculature directly.[36,37] Preceding defecation, high amplitude propagated contractions (HAPC) transfer colonic contents over long distances.[8] Patients with constipation have fewer spontaneous HAPCs than healthy patients[39] and stimulant laxatives, which act directly on the intestinal musculature, can elicit HAPCs which are

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quantitatively similar to naturally occurring HAPCs in healthy patients.[40–42] Similar to stool softeners, severe side effects of stimulant laxatives are uncommon.[36,37]

It appeared that osmotic laxative users had relatively unaffected markers of sleep continuity, unlike the other laxative user groups. It is possible that the use of osmotic laxatives could ameliorate the effects of constipation on sleep continuity in contrast to the other laxative types. However, the observed difference in objective sleep continuity between different laxative user groups may also be due to differences in sample size available as demonstrated by the large confidence intervals of effect estimates (Table 3). It may have been that more patients were using stimulant laxatives such as Senokot and Bisacodyl since they are easier to obtain (over the counter), whereas common osmotic laxatives such as linaclotide and plecanatide are obtained through prescription.[43,44] Conversely, since laxatives may not be included on a patient's medication list unless prescribed, it may be that some laxative types which are more likely to be prescribed are overrepresented in our analyses than laxative types which are bought over the counter and may not be reported. Thus, laxative use may be subject to recall bias, as it was recorded based on patient self-report. Regardless, in this middle-aged/elderly population it appears that laxative use was either unable to ameliorate the impacts of constipation on sleep metrics or that use of these agents contributed to poor sleep outcomes.

This study has several limitations. First, objective assessments of colonic transit and anorectal tests were not available in classifying constipated patients or evaluating constipation severity; the presence of constipation was inferred by self-reported laxative use. Thus, we were unable to control for unreported constipation (not using laxatives) which may bias our analysis. Moreover, frequency of usage/dosage of laxative medications was not available. The presence of insomnia symptoms was also based on simple self-report which may not distinguish other subjective sleep complaints. In addition, unmeasured confounders such as socioeconomic status, depression, and anxiety which affect both sleep and gastrointestinal function may impact our findings. Generalizability of results may be limited due to all patient polysomnography reports used in this study being collected from a single site. Finally, the cross-sectional nature of our study prevents us from establishing causal inferences based on these results. The strengths of this study include the ability to objectively assess several sleep parameters using polysomnography in a large sample of patients.

In summary, to our knowledge, this is the first study to investigate the association between various laxative types with objective (polysomnography-derived) sleep parameters. We demonstrate that laxative use was associated with worse sleep continuity, and this was also observed in the stool softener and stimulant laxative subtypes in middle-aged/elderly patients. Additionally, we demonstrate that patients using laxatives (all types) and stimulant laxatives were at greater odds of reporting insomnia symptoms. The results of this study, using laxative use as a surrogate for constipation, support previous findings on the relationship between constipation and poor sleep continuity and an association with insomnia. The findings of this study support the need for physicians to recognize the potential for poor sleep continuity in patients with chronic constipation and facilitate the reduction of poor sleep outcomes through appropriate management. As our study was cross-sectional, we recommend that future studies adopt a prospective study design to investigate how treatment of constipation impacts PSG-derived markers of sleep.

Supplementary Material. To view supplementary material for this article, please visit http://doi.org/10.1017/cjn.2022.264.

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