Original article

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Relationship of shift work with endoscopic gastritis among workers of an electronics company

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Objectives The current study aimed to examine the cross-sectional association between shift work and gastritis using endoscopic evaluation.

Methods We collected questionnaire data from 964 non-shift workers and 290 shift workers aged 22–40 years at an electronics company, comprising age, smoking status, alcohol consumption, physical activity, occupational stress, and gastrointestinal symptoms. We performed a gastroendoscopy of participants. Along with describing the gastroendoscopic results, we analyzed the correlations between gastritis and shift work using multiple logistic regression analysis.

Results In terms of gastrointestinal symptoms, night shift workers complained more of indigestion than non-shift workers (P<0.01), and the rate of gastritis was higher. The odds of gastritis was significantly higher among shift workers after adjusting for covariates. The odds ratio (OR) for gastritis was 2.24 [95% confidence interval (CI) 1.47–3.43] in shift workers compared with non-shift workers. Among seven subtypes of gastritis, only superficial gastritis was significantly associated with shift work (OR 1.58, 95% CI 1.12–2.24).

Conclusions We found that shift workers experience gastritis more than non-shift workers as well as more gastrointestinal symptoms, particularly indigestion. Using endoscopic findings, our study supports that shift work negatively affects the gastrointestinal system.

Key terms association; gastroendoscopy; gastrointestinal symptom; indigestion; shift worker.

Shift work is defined as night work, rotation work, and/or work during irregular hours (1). Approximately 15–30% of workers worldwide are involved in shift work (2). In South Korea, the rate varies by industry, but about 20% of workers in manufacturing fields are involved in any type of shift work (3), along with 19.3% of workers and electrical and electronics companies in South Korea (4).

Research shows that shift workers suffer from many health problems such as sleep disorders (5, 6), hypertension (7), diabetes (8), metabolic syndrome (9), cardiovascular disease (10), and depression (11). Gastrointestinal problems are also known to be more common among shift workers (12). Specifically, the rate of duodenal ulcer among individuals infected with *Helicobacter pylori* is higher in shift workers (13), and night shift work is suggested to be a risk factor for gastroesophageal reflux disease (GERD) (14).

Investigators in many epidemiologic studies found more frequent gastrointestinal symptoms among shift workers such as dyspepsia and other problems (15–19). However, most research was conducted based on self-reported symptoms, questionnaires, or second-hand data such as hospitalization medical reports. Several researchers incorporated gastroendoscopy, but only for

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peptic ulcer diseases and GERD. To our knowledge, no researchers have conducted endoscopic evaluation of gastritis among shift workers. Therefore, we aimed to analyze if shift work including night work correlated with endoscopic findings of gastritis.

Methods

Study subjects

Our study population comprised employees of an electronics manufacturer of cell phones in South Korea.We recruited a total of 1872 workers (male, 923; female, 949) who had received medical examination at a university hospital in Changwon, South Korea, from May to November 2014. We received informed consent from all study participants to use the data from their questionnaires and the gastric endoscopy examination. We excluded 493 workers who submitted incomplete questionnaires, 83 who were taking non-steroidal anti-inflammatory drugs or aspirin, and 42 who had chronic diseases (cancer, hypertension, diabetes, stroke, coronary disease). Finally, we included 1254 workers in this study, 964 daytime workers and 290 shift workers. The shift workers consisted of two groups with different work schedules, either 4 × 8 hours (morning: 07.00–15.00; afternoon: 15.00–23.00; night: 23.00–07.00) or 3 × 12 hours (day: 08.00–20.00; night: 20.00–08.00). As such, both groups of shift workers included night shift workers. The institutional review board of Samsung Changwon Hospital approved our study (2017-SCMC-12-083).

Study variables and measurement

We investigated the demographic and lifestyle characteristics of the study sample: age, sex, body mass index (BMI), alcohol consumption, smoking status, International Physical Activity Questionnaire short form (IPAQ; IPAQ Research Committee 2005), work experience, and shift work experience. The age range was 20–39 years, and participants were divided into two age groups: 20–29 and 30–39 years. We used BMI to classify subjects as underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), or overweight (≥25.0 kg/m^2), according to the World Health Organization Asia-Pacific criteria 2000) (20). Participants were classified by smoking habits as current smokers, ex-smokers, or non-smokers. Alcohol consumption was classified according to the 2005 US Food and Drug Administration and measured by calculating the average amount of alcohol consumed per week in grams; subjects were classified as non-drinkers, moderate drinkers (<24 g of alcohol per day for men and <12 g for women), or heavy drinkers (24 g of alcohol per day for men and >12 g for women) (21). We combined moderate and heavy drinker together as drinker.

We measured the subjects' physical activity according to the IPAQ (22). The IPAQ was designed to record the frequency and time of intense, moderate, or walking physical activity for 10 minutes or more for a week, which was calculated as metabolic equivalent of task (MET; minutes/week). We recategorized subjects as participating in low, moderate, or high weekly physical activity as follows: (i) low - not meeting the criteria for moderate or high weekly activity; (ii) moderate - any one of the following: (a) ≥3 days of vigorous activity of ≥20 minutes per day or (b) ≥5 days of moderate-intensity activity or walking of ≥30 minutes per day or (c) ≥5 days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum of ≥600 MET-minutes/week; (iii) high: either of the following: (a) vigorous-intensity activity on ≥3 days and accumulating ≥1500 MET-minutes/week or (b) ≥7 days of any combination of walking, moderate-intensity or vigorous intensity activities achieving a minimum of ≥3000 MET-minutes/week.

Marital status was divided into married, single, or other, which comprised separated, divorced, and bereaved. For education level, we categorized subjects with high school graduation as the baseline because only five respondents had not graduated from high school. We evaluated stress in the workers with the Korean Occupational Stress Scale (KOSS), which was developed and standardized to measure occupational stressors in Korean employees (23). We adopted the short form of the KOSS, which consisted of 24 items on 8 subscales: job demand (4 items), insufficient job control (4 items), interpersonal conflict (3 items), job insecurity (2 items), occupational system (7 items), lack of reward (3 items), and organizational climate (4 items). Total scores were summed, and the reference values for occupational stress were 48.4 for males and 50.0 for females; we considered scores above these to reflect high occupational stress.

To investigate subjective complaints, we included the following gastrointestinal symptoms on the questionnaire: difficulty swallowing, acid reflux, nausea or vomiting, indigestion, and heartburn.

Gastroendoscopy

One of seven specialists performed the gastroendoscopy using CF-Q260AI (Olympus Optical Co, Tokyo, Japan), and we retrospectively analyzed the endoscopic results recorded in the medical records. We considered the following endoscopic variations as gastritis: superficial, atrophic, erosive, erythematous, lymphofollicular, hemorrhagic, and metaplastic gastritis. *H pylori* was

checked by endoscopic biopsy and Warthin-Starry silver or modified Giemsa stain.

Statistical analysis

We used descriptive statistics for each category of the following variables: sociodemographic characteristics and shift work experience. To examine the association between night shift work and gastroendoscopic findings, we conducted univariate logistic regression analysis. Separate from the related factors of sex, age (24), BMI (25), smoking status (26), and alcohol consumption (27), we hypothesized that IPAQ score, marriage, education, and KOSS would affect gastroendoscopic findings, and thus, we adjusted for these in the multivariate analyses. All statistical tests were performed using SAS 9.4 (SAS Institute, Cary, NC, USA). Statistical significance was set at 0.05. Odds ratio (OR) and 95% confidence intervals (CI) for gastritis of shift work were estimated from logistic regression.

Results

There were 1254 study subjects, 737 (58.8%) males and 517 (41.2%) females, of whom 964 were daytime fixed workers and 290 shift workers, with shift work schedules categorized as described earlier. We categorized duration of shift work as <5 years (64 workers, 21.9%), 5–9 years (77 workers, 26.4%), 10–14 years (138, 47.3%), or >15–≤20 years (12 workers, 4.1%). Only one worker (0.3%) had worked shift work for >20 years.

There was a high percentage of females among the shift workers, and more workers >30 years in the daytime employee group. Current smokers were more common in the day shift workers, along with heavy drinking, being married, high (obese) BMI, and above college education (table 1).

Gastrointestinal complaints were more common in shift workers except for nausea and vomiting; in particular, indigestion was significantly high among shift workers (P<0.001) (table 2). We found more endoscopic findings of gastritis in shift compared to daytime workers (72.1% versus 71.1%), but the difference was not significant. Superficial gastritis, lymphofollicular gastritis, hemorrhagic gastritis and *H pylori* were also more common among shift workers, but this difference was also not significant (table 3).

After adjusting for sex, age, BMI, smoking and alcohol (model 2), the OR for gastritis in shift compared to daytime workers was 2.34 (95% CI 1.54–3.56). After adjusting for sex, age, smoking, alcohol consumption, BMI, IPAQ, marriage, education, and KOSS (model 3), the OR was 2.24 (95% CI 1.47–3.43). Analysis found a

Table 1. General characteristics of daytime and shift workers. [BMI=body mass index; IPAQ= International Physical Activity Questionnaire short form; KOSS=the Korean Occupational Stress Scale.]

	Total N=1254	
	Daytime workers	Shift workers
	N (%)	N (%)
Sex [a]	964	290
Male	598 (62.0)	139 (47.9)
Female	366 (38.0)	151 (52.1)
Age (years) [a]		
22–30	238 (24.7)	132 (45.5)
31–40	726 (75.3)	158 (54.5)
Smoking [a]		
Never	494 (51.2)	199 (68.6)
Former	262 (27.2)	26 (9.0)
Current	208 (21.6)	65 (22.4)
Alcohol [a]		
No	391 (40.6)	196 (67.6)
Yes	573 (59.4)	94 (32.4)
BMI [a]		
<18.5	51 (5.3)	18 (6.2)
18.5–24.9	600 (62.2)	206 (71.0)
≥25.0	313 (32.5)	66 (22.8)
IPAQ		
Insufficiently active	522 (54.1)	148 (51.0)
Sufficiently active	442 (45.9)	142 (49.0)
Marital status [a]		
Married	816 (86.6)	217 (77.2)
Single	120 (12.7)	64 (22.8)
Others	6 (0.64)	0 (0)
Education [a]		
≤ High school	266 (27.9)	116 (40.6)
≤ College	612 (64.2)	159 (55.6)
≥ Graduate school	75 (7.9)	11 (3.8)
KOSS		
Low	187 (23.4)	42 (20.7)
High	613 (76.6)	161 (79.3)

[a] Denotes difference between groups, P<0.05 by Chi-square test.

Table 2. Gastrointestinal symptoms of subjects.

	Daytime workers	Shift workers
	N (%)	N (%)
Difficulty swallowing	8 (0.83)	4 (1.38)
Acid reflux	70 (7.28)	27 (9.34)
Nausea or vomiting	44 (4.58)	13 (4.50)
Indigestion [a]	185 (19.25)	83 (28.72)
Heartburn	95 (9.89)	37 (12.80)

[a] Denotes difference between groups, P<0.05 by Chi-square test or Fisher's exact test.

Table 3. Gastroendoscopic findings of subjects.

	Daytime workers	Shift workers	P-value [a]
	N (%)	N (%)	
Normal	279 (28.9)	81 (27.9)	0.74
Gastritis	685 (71.1)	209 (72.1)	0.74
Superficial	333 (34.5)	112 (38.6)	0.20
Atrophic	235 (24.4)	58 (20.0)	0.12
Erosive	104 (10.8)	27 (9.3)	0.47
Erythematous	68 (7.1)	12 (4.1)	0.07
Lymphofollicular	21 (2.2)	12 (4.1)	0.07
Hemorrhagic	18 (1.9)	6 (2.1)	0.83
Metaplastic	25 (2.6)	5 (1.7)	0.40
Helicobacter pylori	26 (2.7)	8 (2.8)	0.96

[a] Chi-square test assessed.

strong association between age and gastritis (OR 3.92, 95% CI 2.72–5.65) and age and alcohol consumption (OR 2.90, 95% CI 2.08–4.03). Male gender, smoking, and high KOSS score were positively associated with gastritis, while IPAQ score, single status and low education level were negatively related; however, not all relationships were significant (table 4).

Looking at shift work duration, the OR for gastritis was 1.19 (95% CI 0.53–2.37) for 5–9 years, 1.31 (95% CI 0.58–2.98) for 10–14 years, and 0.5 for ≥15 years. The OR for gastritis by shift were 1.07 for those in the 3×12-hour shift (95% CI 0.58–2.00) versus the 4×8-hour shift. There was a positive trend of duration and intensity of shift work with odds of gastritis, but both tests for trend were not statistically significant.

Shift workers showed more indications of all types of gastritis except for erythematous gastritis. However, only superficial gastritis (OR 1.58, 95% CI 1.12–2.24) was significantly higher after we adjusted for the above confounding factors (table 5).

Discussion

In this study, using gastroendoscopy, night shift work was more associated with gastritis than day shift work, and shift workers reported more gastrointestinal symptoms. Age and alcohol consumption were also positively associated with gastritis. With the exception of erythematous, shift workers showed more of all types of gastritis; superficial gastritis was significantly high.

Circadian physiology plays a crucial role in the pathogeneses of these diseases, and gastric emptying is one of the most important functions of circadian rhythm (28). In addition, impaired circadian rhythm can decrease the release of cell protective factors at night and increase the release of mucosal aggressive mediators (28). Therefore, shift workers who have disrupted circadian rhythm are likely to have more problems with gastric functions. Several mechanisms are reported for the increased prevalence of digestive diseases among

Table 4. Multivariate logistic regression results for endoscopic gastritis. [BMI=body mass index; CI=confidence interval; OR=odds ratio; IPAQ=International Physical Activity Questionnaire short form; KOSS=the Korean Occupational Stress Scale.]

	Gastritis			
	Crude	Model 1 [a]	Model 2 [b]	Model 3 [c]
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
Shift work				
No	1	1	1	1
Yes	1.02 (0.76–1.37)	1.81 (1.22–2.69)	2.34 (1.54–3.56)	2.24 (1.47–3.43)
Sex				
Female	1	1	1	1
Male	1.67 (1.31–2.15)	1.58 (1.14–2.19)	1.32 (0.90–1.93)	1.31 (0.87–1.98)
Age				
22–30	1	1	1	1
31–40	4.01 (3.08–5.21)	4.21 (3.07–5.79)	3.37 (2.41–4.70)	3.92 (2.72–5.65)
BMI (kg/m^2)				
<18.5	1		1	1
18.5–24.9	1.21 (0.72–2.04)		0.65 (0.30–1.43)	0.60 (0.27–1.35)
≥25.0	1.50 (0.86–2.60)		0.88 (0.38–2.01)	0.81 (0.35–1.88)
Smoking				
Never	1		1	1
Former	1.63 (1.19–2.23)		1.41 (0.95–2.11)	1.40 (0.92–2.11)
Current	2.29 (1.62–3.23)		1.62 (1.06–2.47)	1.69 (1.09–2.62)
Alcohol				
No	1		1	1
Yes	3.67 (2.82–4.77)		3.10 (2.24–4.28)	2.90 (2.08–4.03)
IPAQ				
Insufficiently active	1			1
Sufficiently active	0.55 (0.43–0.70)			0.46 (0.33–0.63)
Marital status				
Married	1			1
Single	0.71 (0.51–1.00)			1.42 (0.88–2.27)
Others	1.86 (0.22–15.98)			2.03 (0.21–19.93)
Education				
≤ High school	1			1
≤ College	1.08 (0.82–1.42)			0.84 (0.58–1.22)
≥ Graduate school	1.07 (0.64–1.80)			0.88 (0.45–1.72)
KOSS				
No	1			1
Yes	0.96 (0.69–1.34)			1.05 (0.71–1.56)

[a] Adjusted for sex and age.
[b] Adjusted for sex, age, BMI, smoking and alcohol.
[c] Adjusted for sex, age, BMI, smoking, alcohol, IPAQ, marital status, education and KOSS.

Table 5. Odds ratios (OR) of specific gastritis after adjustment for possible confounding factors. [CI=confidence interval.]

	Daytime workers	Shift workers
	(95 % CI)	OR (95 % CI)
Gastritis		
Superficial	1	1.58 (1.12–2.24)
Atrophic	1	1.14 (0.76–1.71)
Erosive	1	1.09 (0.64–1.85)
Erythematous	1	0.54 (0.24–1.18)
Others [a]	1	1.00 (0.47–2.13)

[a] Lymphofollicular, hemorrhagic and metaplastic gastritis

shift workers, but circadian rhythms and "gut clock" genes are the most essential influences (30). Normal circadian rhythms make digestive movements active in daytime and inactive at night, but shift work causes insufficient secretion of digestive enzymes and unbalanced acidity. Circadian rhythms also affect appetite regulation, and shift workers inevitably consume late night snacks, which causes them to ingest more calories in the course of irregular diet habits. In addition, night shift workers have higher caffeine intake and excessive calorie intake (31). Consequently, many of these workers have gastrointestinal problems.

Nocturnal sleep deprivation and psychological stress in shift work may increase gastric secretion (32) which reduced mucosal defense (33). Gastrin, which stimulates the secretion of gastric acid, and pepsin, which is transformed from pepsinogen in the presence of hydrochloric acid, can aggravate peptic ulcers (34). Tarquini et al (35) showed increased level of gastrin and pepsinogen in shift workers. Reduced natural defense deteriorates *H pylori* infection in gastric mucosa. Zober et al (36) showed *H pylori* infection was more prevalent among shift workers. Superficial gastritis patients included inflammatory cell infiltration and superficial edema in mucosal. Superficial gastritis is mostly related with *H pylori* infection and may progress to atrophic gastritis refers to the finding of variable gland loss (37, 38). The study population in their 20s and 30s was relatively young and earlier superficial gastritis could be dominant. Among gastrointestinal symptoms, only indigestion was associated with shift work. Difficulty swallowing and acid reflux was more related to reflux esophagitis and indigestion was a milder symptom than nausea, vomiting and heartburn. This also could be more relevant to superficial gastritis.

Generally, other detrimental factors affect gastric functions. Aging is the most important factor, but alcohol consumption, smoking, dietary habits, physical activity, and underlying diseases affect also gastric functions. The psychosocial burden from shift work also affects peptic ulcer and inflammatory bowel diseases (39). We analyzed the effects of age, alcohol consumption, smoking, BMI, physical activity, and social level with education and marital status as well as psychologic factors of work stress. After we adjusted for these confounders, shift work negatively affected endoscopic findings of gastritis.

The Sydney system for classification of gastritis was promulgated for clinical and research purposes and is considered more representative and objective because it is based on pathological evidence (40). The Sydney system is not a classification in strict terms because it is more complex to apply to general medical check-ups; thus, we adopted a more practical classification based on morphology.

It seems clear that shift work has negative impacts, but it is possible that over time, some individuals might adapt to shift work such that their bodies normalize to their new schedules. Future studies are needed to determine whether longer durations of shift work affect for digestive system negatively or positively. In addition, workload and emotional stress can affect gastric functions.

Our study had several limitations. First, more large-scale prospective studies are required to examine the potential association between shift work and gastritis. Second, endoscopic finding of gastritis is subjective by specialist, and thus, cross-validation in another study will add credibility. Third, most of the study sample were relatively young (in their 20s and 30s); consequently the effects of shift work could not have been strong. These results should be interpreted taking into account the healthy worker effect. Fourth, we could not rely solely on *H pylori* infection, which is one of the most important factors regarding gastritis. In this study, *H pylori* was checked by endoscopic biopsy and Warthin-Starry silver or modified Giemsa stain, but campylobacter-like organism test and serum *H pylori* immunoglobulin G antibody test would give clearer results. Fifth, we adjusted several variables (eg, smoking, alcohol consumption, physical inactivity) that are known to affect gastric health negatively. However, we could not consider individuals' diets, including caffeine intake. Caffeine contained in coffee stimulate gastrin releasing and stomach acid secretion. Coffee also prolongs the relaxation of proximal stomach and could slow gastric emptying (41).

With regard to the study population, we included as many participants as possible, and all subjects underwent gastroendoscopy. However, the study group came from an electronic device manufacturing company, and the work environment and shift work schedules at this factory could be different from other industries, which could in turn give different results from those of our study.

Concluding remarks

Using gastroendoscopic findings, we found higher OR for gastritis among shift compared to daytime work-

ers after we adjusted for covariates. Therefore, using endoscopic evidence, our study supports that shift work negatively affects gastric diseases. This is the first study to provide gastroendoscopic findings among healthy asymptomatic workers, but more studies are needed regarding specific gastroendoscopic findings with respect to shift work in different workplace settings.

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