Differences between fixed day shift workers and rotating shift workers in gastrointestinal problems: a systematic review and meta-analysis

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Abstract: This study comprised a review and compilation of literature to gain an in-depth understanding of the impact of rotating shift work on gastrointestinal health. PubMed, CINAHL, and the Cochrane Library were searched for studies published between January 1, 1985, and June 30, 2020. Fixed day shifts were defined as work shifts that began between 7:00 and 9:00 in the morning. Shifts beginning at any other time were classified as rotating shifts. A meta-analysis was performed using Comprehensive Meta-Analysis Software (CMA) version 3. In the end, 16 studies were included in the meta-analysis. An odds ratio (OR) of 1.56 (95% confidence interval (CI): 1.24–1.95), indicating that gastrointestinal problems are more common in rotating shift workers than in fixed day shift workers. Four gastrointestinal problems, namely, irritable bowel syndrome, constipation, indigestion, and peptic ulcers, were then analyzed separately. Significant differences between rotating shift workers and fixed day shift workers were found only for indigestion and peptic ulcers. For indigestion, the OR was 1.72 (95% CI: 1.28–2.30). For peptic ulcers, the OR was 1.66 (95% CI: 1.19–2.30). Thus, research indicates that rotating shift work may increase the risk of gastrointestinal problems, particularly indigestion and peptic ulcers.

Key words: Fixed day shift, Rotating shift, Worker, Gastrointestinal problems, Meta-analysis

Introduction

Rotating shift work refers to a situation when over half of the working period falls outside of the period beginning between 7:00 and 9:00 in the morning and ending between 6:00 and 8:00 in the evening1, 2). It is a challenge to an individual’s biological rhythms due to disruptions to the body’s circadian rhythms and effects on hormone secretion and regulation3). For the sake of their jobs, rotating shift workers must be active during time periods when they should normally be resting or sleeping. As a consequence, their physiological systems must readjust; however, whether a new steady state can be achieved is still inconclusive4).

Gastrointestinal activity and functions in the human body are regulated by circadian rhythms 24 h a day5). Gastrointestinal motility and gastric acid secretion are both associated with the biological clock. Rotating shift workers often have irregular daily routines, often resulting in irregular meals and high fat intake as well as increasing the risk of gastrointestinal diseases6, 7). In another aspect, rotating
shift workers are likely to change the time, frequency, and contents of their meals\textsuperscript{8}). Gastrointestinal dysfunction are more common among rotating shift workers than among fixed day shift workers\textsuperscript{9}). Examples include constipation due to altered bowel habits, or functional dyspepsia, the symptoms of which include upper abdominal pain, flatulence, loss of appetite, nausea, and vomiting. Severe cases may involve peptic ulcers\textsuperscript{10, 11}).

The large intestine has its own biological clock. Upon waking, gastrointestinal motility increases and tends to trigger the need to defecate\textsuperscript{(2)}. However, long-term rotating shift work often disrupts these physiological rhythms, which severely affects this biological clock and is associated with intestinal maladjustment, resulting in unpleasant symptoms such as diarrhea, flatulence, constipation, and abdominal pain\textsuperscript{13, 14}). Nojkov et al. observed that gastrointestinal complaints which overlap with irritable bowel syndrome (IBS) occur more frequently in rotating shift workers than in fixed day shift workers (48% vs. 31%, \(p<0.01\))\textsuperscript{(14)}.

In summary, we derive that IBS, peptic ulcers, constipation, and indigestion are gastrointestinal problems from which rotating shift workers often suffer. The impact of rotating shift work on worker health has been receiving more attention from experts and researchers in recent years, and a substantial amount of empirical data have been used to explore this issue\textsuperscript{15–17}). Gastrointestinal problems are likely to further contribute to decreased levels of alertness and increased irritability, which are already known to negatively impact the behavior of shift workers\textsuperscript{16}). The authors thus aimed to systematically compile relevant research to examine existing evidence regarding the influence of rotating shift work on the gastrointestinal tract, including gastrointestinal problems such as IBS, peptic ulcers, constipation, and indigestion.

**Subjects and Methods**

**Literature search and quality**

This study involved a systematic review of literature obtained from the Cochrane Library, PubMed, and the Cumulative Index to Nursing and Allied Health Literature (CINAHL) in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework\textsuperscript{(18)}. The literature search was conducted using synonyms of gastrointestinal\textsuperscript{*} in coordination with Boolean logic skills and the keyword string (((((shift work) OR (rotating shift)) AND (gastrointestinal*))) OR (constipation)) OR (indigestion)) OR (dyspepsia). Figure 1 presents the screening process. Studies on rotating shift workers (defined as individuals working shifts other than fixed day shifts) over the age of 20 and published between January 1, 1985, and June 30, 2020, were included. No gender restrictions were applied. Although minors (i.e., under the age of 20) working rotating shifts may also experience specific health considerations, we focused only on rotating shift workers over the age of 20. Fixed day shifts in our meta-analysis were permanent shifts in which work shifts began between 7:00 and 9:00 in the morning, whereas rotating shifts were not permanent or began at other times. Studies with inadequate raw data (studies that did not provide the numbers of fixed day shift or rotating shift workers), studies not published in English, duplicates, and argumentative or systemic reviews were excluded. The quality of the selected studies was assessed using the critical appraisal instruments developed by the Joanna Briggs Institute (JBI)\textsuperscript{(19)}. We reviewed whether the studies met the following criteria: (1) the criteria for inclusion in the sample were clearly defined (fixed day shifts and rotating shifts were clearly defined), (2) the study subjects and the setting were described in detail, (3) the exposure was measured in a valid and reliable way, (4) objective and standard criteria were used for the measurement of the condition (clear diagnostic methods were used for IBS, peptic ulcers, constipation, and indigestion; and the numbers of patients diagnosed with each condition were clearly stated), (5) confounding factors were identified, (6) strategies to deal with confounding factors were stated, (7) the outcomes were measured in a valid and reliable way, and (8) appropriate statistical analysis was used. Only studies that met six or more of these eight criteria were included in our meta-analysis. The appraisals were done by the two authors separately. The response for each item was “No”, “Yes”, or “Unclear”. “Yes” responses received 1 point, and 0 points were given for any other response.

**Data analysis**

Data analysis was performed using the software package Comprehensive Meta-Analysis (CMA) 3.0. The variance among the results of the 16 studies (heterogeneity or homogeneity) was examined using Cochran’s Q test, and the relative importance and direction of the research outcomes of the studies were displayed using forest plots, with the fixed effect model or the random effects model chosen to calculate the pooled odds ratio (OR). Subgroup analysis was applied to studies that were found to have heterogeneity, meaning that separate meta-analyses were used for the
four types of common gastrointestinal problems (namely IBS, peptic ulcers, constipation, and indigestion). Furthermore, sensitivity analysis was conducted in the event that a study was found to have heterogeneity. Sensitivity analysis was conducted to determine whether the elimination of any study would influence the overall results. Funnel plots and Egger’s test were employed to test for publication bias. Funnel plots were used to examine whether the positive or negative effects of the various study results were symmetric, and then Egger’s regression was applied.

Results

We obtained a total of 627 studies. After eliminating duplicates and studies not published in English, we derived 465 studies. We then screened the studies by title and abstract and examined them using our inclusion and exclusion criteria, which resulted in 16 studies. Figure 1 displays the search process. The selected studies were appraised using the instruments developed by JBI. The total scores of all 16 studies were 6–7 points, so no studies were eliminated following the appraisal process. The Kappa value for the inter-rater reliability of the two experts was 0.897, thereby indicating extremely high consistency and significant correlation between the ratings given by the experts. Extraction of the research data was conducted using a standard form, and the research designs and data compilation in the 16 studies are presented in Table 1.

Overall analysis

Focusing on rotating shifts and fixed day shifts in different types of occupations, assessing different gastrointestinal problems, and using different methods to confirm gastrointestinal problems all may have led to the high heterogeneity among the 16 studies ($I^2$: 73.16% $p$<0.001); thus, the random effects model was used. The OR presented by the forest plot was 1.56 (95% confidence interval: 1.24–1.95, $p$<0.001), meaning that rotating shift workers were more likely to suffer from gastrointestinal problems such as IBS, peptic ulcers, constipation, and indigestion than were fixed day shift workers (Fig. 2). Furthermore, the sensitivity analysis indicated that the elimination of...
| First author (yr) | Country | Design | Subjects | Gender | Age (Mean, SD) | Definition of shift work | GI problem | GI problem confirmation standard or instrument | Shift work | Day work | Quality score |
|-------------------|---------|--------|----------|--------|---------------|-------------------------|------------|-----------------------------------------------|------------|----------|--------------|
| Abedini (2015)    | Iran    | Cross-sectional | Hospital security | M | Day: 35.12 (8.90) Shift: 36.57 (9.68) | Non-permanent day shifts; working for 12 h and then resting for 24 h, working for 8 h and then resting for 16 h, or working from 7:00 in the evening to 7:00 in the morning | Indigestion | Shift-workers Questionnaire | 209 | 22 | 6/8 |
| Ahmed (2017)      | Egypt   | Cross-sectional | Nurses | M/F | 34.7 (10.2) | Non-permanent day shifts; both fixed shifts and non-fixed shifts | Indigestion | Gastrointestinal Symptom | 112 | 34 | 6/8 |
| Buja (2013)       | Italy   | Cross-sectional | Nurses | M/F | 38.04 (8.2) | Non-permanent day shifts; both with night shifts (alternating among morning, afternoon, and night shifts) and without night shifts (alternating between morning and afternoon shifts) | Indigestion | Job Content Questionnaire | 394 | 264 | 6/8 |
| Fido (2008)       | Kuwait  | Cross-sectional | Oil factory workers | M | Day: 34.5 (7.4) Shift: 34.2 (7.3) | Alternating among morning, afternoon, and night shifts | Constipation | Self-created general health and work performance Questionnaires | 200 | 83 | 7/8 |
| Ibrahim (2016)    | Saudi Arabia | Cross-sectional | Nurses | M/F | 36.5 (9.2) | Working in alternating shifts after day shift | IBS | Rome III Questionnaire | 152 | 15 | 6/8 |
| Jang (2017)       | Korea   | Cross-sectional | Firefighters | M/F | 44% were 40–49 yr old | Any form of work except for daytime work | IBS | Rome III Questionnaire | 1,039 | 97 | 6/8 |
| Kim (2013)        | Korea   | Cross-sectional | Nurses | M/F | 32.3 (7.8) | Any form of work except for daytime work | Indigestion | Short-Form Bowel Disease Questionnaires | 147 | 29 | 7/8 |
| Koh (2014)        | Korea   | Cross-sectional | Nurses | M/F | GI problems: 28.12 (4.88) No GI problems: 29.48 (6.43) | Any form of work except for daytime shifts | Indigestion | Rome III Questionnaire | 203 | 45 | 6/8 |
| Liu (2014)        | China   | Cross-sectional | Nurses | M/F | 31.47 (7.59) | Working night shifts at least 5 nights a month | IBS | Rome III Questionnaire | 73 | 7 | 6/8 |
| Mendes (2012)     | Brazil  | Cross-sectional | Nurses | M/F | 33.1 | Working night shifts for 12 h each shift | Indigestion | Self-created Questionnaire | 52 | 26 | 6/8 |
| Najafimehr (2019) | Iran    | Cross-sectional | Auto factory workers | M | 36.46 (4.90) | Alternating among morning, afternoon, and night shifts each week | Constipation | Rome IV Questionnaire | 3,170 | 320 | 6/8 |
| First author (yr) | Country | Design | Subjects | Gender | Age (Mean, SD) | Definition of shift work | GI problem | GI problem confirmation standard or instrument | Shift work Total case | Day work Total case | Quality score |
|------------------|---------|--------|----------|--------|---------------|--------------------------|------------|--------------------------------|---------------------|-----------------|--------------|
| Nojkov (2010)   | USA     | Cross-sectional | Nurses   | M/F    | Day: 45.6 (9.3) Night Shift: 41.5 (11.0) Rotating shift: 37.3 (10.8) | Fixed night shifts or alternating between day and night shifts | IBS | Rome III Questionnaire<sup>a</sup> | 185 | 80 | 214 | 66 | 6/8 |
| Pietroiuisti (2006) | Italy | Cross-sectional | Not specified | M/F | Day: 39.13 (9.88) Shift: 40.54 (10.20) | Night shifts or working night shifts at least 4 nights a month | Peptic ulcers | Endoscopic examination | 185 | 25 | 214 | 29 | 6/8 |
| Saberi (2010) | Iran | Cross-sectional | Nurses | M/F | Day: 35 Shift: 38.5 | Any form of work except for fixed day shifts | Constipation | Gastrointestinal Symptom Questionnaire<sup>b</sup> | 133 | 50 | 27 | 10 | 6/8 |
| Segawa (1987)   | Japan   | Cross-sectional | Finance/public sector employees | - | 43% were 40–49 yr old | Night shifts | Peptic ulcers | Endoscopic examination | 2,269 | 103 | 6,525 | 225 | 6/8 |
| Sugisawa (1998) | Japan   | Longitudinal | Not specified | M | 46.7 (range 30–59) | Including fixed night shifts; alternating between morning and afternoon shifts; alternating among morning, afternoon, and night shifts; alternating between day and night shifts; and irregular shifts | Peptic ulcers | Endoscopic examination | 4,321 | 249 | 4,684 | 180 | 7/8 |

GI problems: gastrointestinal problems; IBS: irritable bowel syndrome; M: male; F: female.

<sup>a</sup>Confirmation of indigestion and peptic ulcers in Shift-workers Questionnaire: A total score of 2 or higher from subjective responses to question items regarding gastrointestinal problems in the previous weeks and measured on a four-point Likert scale (1–4 points).

<sup>b</sup>Confirmation of constipation and indigestion in Gastrointestinal Symptom Rating Scale: Subjective responses to question items regarding gastrointestinal problems in the previous weeks and measured on a four-point Likert scale (1–4 points).

<sup>c</sup>Confirmation of constipation and indigestion in Job Content Questionnaire: Response selected for whether constipation or indigestion was often experienced during the past 12 months in the physical demand scales.

<sup>d</sup>Confirmation of constipation in self-created General Health and Work Performance Questionnaire: A “usually”, “sometimes”, or “none” response selected for whether constipation was experienced during the past three months.

<sup>e</sup>Confirmation of IBS in Rome III Questionnaire: Repeated abdominal pain or discomfort associated with changes in stool frequency and/or form during the past six months and symptoms continuing for three days or more each month during the past three months.

<sup>f</sup>Confirmation of IBS in IBS Severity Scoring System: Responses regarding abdominal pain, duration of abdominal pain in days, severity of abdominal distention, satisfaction with bowel habits, and interference with quality of life over the past 10 d; the total score of the system was 500 points, where 75–175 points indicated mild IBS, 175–300 points indicated moderate IBS, and 301 points or higher indicated severe IBS.

<sup>g</sup>Confirmation of indigestion in Short-Form Bowel Disease Questionnaires: Discomfort or stomach pain after meals during the past three months but with endoscopic inspections revealing no structural diseases.

<sup>h</sup>Confirmation of constipation in Gastrointestinal Symptom Questionnaire: Subjective responses to question items regarding constipation in the past four weeks and measured on a seven-point Likert scale (0–6 points).

<sup>i</sup>Confirmation of indigestion in self-created questionnaire: A “no”, “seldom”, or “always” response selected for the indigestion question item in health symptoms of nurses who had worked for at least a month.

<sup>j</sup>Confirmation of constipation in Rome IV Questionnaire: Experiencing straining, hard stools, sensation of incomplete evacuation, sensation of anorectal obstruction, use of digital evacuation, and fewer than three spontaneous bowel movements per week at least a quarter of the time in at least three months during the past six months; not passing soft stools without laxatives and not meeting symptoms of IBS.
any study did not exert a significant impact on the pooling OR (95% CI: 1.24–1.95) (Fig. 3). Our funnel plot (Fig. 4) and linear regression (Egger’s) analysis (p=0.915) showed no evidence of publication bias among the studies included in our meta-analysis.

Subgroup analysis: Irritable Bowel Syndrome (IBS)

All six studies involving IBS used the Rome III Questionnaire to confirm IBS diagnoses; however, these studies focused on rotating shift and fixed day shift workers in different occupations, which may have led to the high heterogeneity (I²: 77.07%, p=0.001). Thus, the random effects model was used. The OR presented by the forest plot was 1.05 (95% CI: 0.60–1.82, p=0.863) (Fig. 2). The ORs derived by Ibrahim et al.24) and Liu et al.27) were 0.36 and 0.44, respectively, which were higher than those obtained by Jang et al.25), Kim et al.13), Koh et al.26), and Nojkov et al.14). The relative weight derived by Nojkov et al.14) was 19.80%, which was greater than those obtained by Jang et al.25), Kim et al.13), Koh et al.26), and Nojkov et al.14). Furthermore, our
sensitivity analysis revealed that the removal of any study did not significantly change the pooling OR (95% CI: 0.60–1.82) (Fig. 3).

**Subgroup analysis: constipation**

All six studies involving constipation focused on rotating shift and fixed day shift workers in different occupations, which may explain the high heterogeneity ($I^2$: 84.99%, $p<0.001$). Thus, the random effects model was used. The OR presented by the forest plot was 1.82 (95% CI: 0.94–3.54, $p=0.078$) (Fig. 2). The OR derived by Fido et al. was 8.75, which was higher than those obtained by Ahmed and Oraby, Buja et al., Najafimehr et al., Nojkov et al., and Saberi and Moravveji. The relative weight derived by Najafimehr et al. was 18.59%, which was greater than those obtained by Ahmed and Oraby.

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**IBS: Irritable bowel syndrome.**

| First author (Year) | Statistics with study removed | OR (95% CI) | OR and 95% CI |
|---------------------|--------------------------------|-------------|---------------|
| Ibrahim (2016)$^{24}$ | 1.31 (0.82, 2.07) | | |
| Jang (2017)$^{25}$ | 1.01 (0.50, 2.03) | | |
| Kim (2013)$^{13}$ | 0.90 (0.49, 1.64) | | |
| Koh (2014)$^{16}$ | 0.99 (0.51, 1.92) | | |
| Liu (2014)$^{27}$ | 1.23 (0.71, 2.12) | | |
| Nojkov (2010)$^{14}$ | 0.93 (0.48, 1.82) | | |

**IBS (Random effects)**

| Ahmed (2017)$^{21}$ | 1.95 (0.92, 4.14) | | |
| Buja (2013)$^{22}$ | 1.82 (0.80, 4.13) | | |
| Fido (2008)$^{23}$ | 1.39 (1.06, 1.83) | | |
| Najafimehr (2019)$^{29}$ | 1.84 (0.76, 4.47) | | |
| Nojkov (2010)$^{14}$ | 2.06 (0.97, 4.40) | | |
| Saberi (2010)$^{31}$ | 2.01 (0.95, 4.26) | | |

**Constipation (Random effects)**

| Abedini (2015)$^{20}$ | 1.57 (1.15, 2.15) | | |
| Ahmed (2017)$^{21}$ | 1.64 (1.20, 2.25) | | |
| Buja (2013)$^{22}$ | 1.72 (1.23, 2.40) | | |
| Kim (2013)$^{13}$ | 1.90 (1.38, 2.61) | | |
| Koh (2014)$^{16}$ | 1.71 (1.23, 2.39) | | |
| Mendes (2012)$^{28}$ | 1.77 (1.28, 2.45) | | |

**Indigestion (Fixed effects)**

| Abedini (2015)$^{20}$ | 1.78 (1.20, 2.63) | | |
| Pietroliusti (2006)$^{20}$ | 1.44 (1.24, 1.66) | | |
| Segawa (1987)$^{22}$ | 1.90 (1.07, 3.38) | | |
| Sugisawa (1998)$^{33}$ | 1.82 (0.95, 2.46) | | |

**Peptic ulcers (Random effects)**

| 1.66 (1.19, 2.30) | | | |

**Overall Analysis (Random effects)**

| 1.56 (1.24, 1.95) | | | |

**Test for overall effect: Z=3.84, p<0.001**

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Fig. 3. Sensitivity analysis of differences in gastrointestinal problems between fixed day shift workers and rotating shift workers.

*■Single Study Result; —confidence interval; ●Combined Effect.

IBS: Irritable bowel syndrome.
Buja et al., Fido et al., Nojkov et al., and Saberi and Moravveji. Furthermore, our sensitivity analysis revealed that the removal of any study did not significantly change the pooling OR (95% CI: 0.94–3.54) (Fig. 3).

Subgroup analysis: indigestion

All six studies involving constipation focused on indigestion in nurses, and the heterogeneity test showed no significant differences ($I^2$: 1.63%, $p=0.406$). Thus, the fixed effect model was used. The OR presented by the forest plot was 1.71 (95% CI: 1.28–2.30, $p<0.001$) (Fig. 2). The ORs derived by Abedini et al., Ahmed and Oraby, and Kim et al. were 3.36 and 2.34, respectively, which were higher than those obtained by Buja et al., Koh et al., and Mendes and De Martino. The relative weights derived by Buja et al., Koh et al., and Mendes and De Martino were 22.92% and 20.30%, respectively, which were greater than those obtained by Abedini et al., Ahmed and Oraby, Pietroiusti et al., and Segawa et al. Furthermore, our sensitivity analysis revealed that the removal of any study did not significantly change the pooling OR (95% CI: 1.28–2.30) (Fig. 3).

Subgroup analysis: peptic ulcers

All four studies involving peptic ulcers focused on rotating shift and fixed day shift workers in different occupations, which may explain the high heterogeneity ($I^2$: 72.45%, $p=0.012$). Thus, the random effects model was used. The OR presented by the forest plot was 1.66 (95% CI: 1.19–2.30, $p=0.003$) (Fig. 2). The OR derived by Pietroiusti et al. was 3.92, which was higher than those obtained by Abedini et al., Segawa et al., and Sugisawa and Uehata. The relative weight derived by Sugisawa and Uehata was 34.27%, which was greater than those obtained by Abedini et al., Pietroiusti et al., and Segawa et al. Furthermore, our sensitivity analysis revealed that the removal of any study did not significantly change the pooling OR (95% CI: 1.19–2.30) (Fig. 3).

Discussion

The meta-analysis in this study indicated that rotating shift work may increase the risk of gastrointestinal problems. Regarding four gastrointestinal problems, namely, IBS, constipation, indigestion, and peptic ulcers, indigestion and peptic ulcers have the only significant impact on rotating shift workers.

Although a number of past studies found a higher incidence of IBS in rotating shift workers than in fixed day shift workers, the results of our meta-analysis revealed no significant differences between rotating shift workers and fixed day shift workers with regard to IBS, constipation, indigestion, and peptic ulcers. IBS is a chronic-recurrent functional inflammatory bowel disease, the main symptoms of which include abdominal pain, bloating or abdominal discomfort, and changes in bowel habits and/or movements. However, the above symptoms are often underestimated, ignored, or mistaken for chronic constipation or diarrhea caused by spoiled or contaminated food, all of which can lead to a delayed diagnosis. This could explain why the rotating shift workers and fixed day shift workers in this meta-analysis displayed exhibited no significant differences in IBS symptoms. Furthermore, the symptoms of IBS are very similar to those of inflammatory bowel disease (IBD). Whereas the inflammation of the intestinal mucosa caused by IBD often results in intestinal mucosal ulcers and may even cause structural damage to the intestines, the intestinal mucosa of IBS patients usually show no substantial abnormalities. Therefore, a correct di-
nomic dysfunction and stress. Rotating shift work may also alter bowel rhythms and can cause gastrointestinal problems. Indigestion and peptic ulcers may also occur in rotating shift workers. We speculate that this is because gastric acid secretion has regular circadian rhythms. The consumption of food by rotating shift workers during the night coincides with slow gastrointestinal motility, delayed emptying, and increased gastric acid secretion, all of which can lead to poor digestion and peptic ulcers. This could explain the differences between the findings for poor digestion and peptic ulcers and those for constipation and IBS.

The effects on indigestion may relate to an acid-base imbalance in the body as well as changes in digestive enzyme function, which increase the risk of digestive dysfunction, such as peptic ulcers and functional dyspepsia in rotating shift workers. Our meta-analysis revealed significant differences between rotating shift workers and fixed day shift workers in terms of indigestion and peptic ulcers. Fixed day shift workers eat their meals more regularly and at more regular times, and endogenous rhythms will prompt movement and secretions in the digestive tract to automatically exhibit anticipatory reactions in the body.
time period before meals in order to provide optimal conditions for the digestion, absorption, and emptying of food that is consumed\(^7\). In contrast, rotating shift work often results in irregular meals and irregular mealtimes. Regular meals stimulate conditioned reflexes in the cerebral cortex, which induce digestive secretions that facilitate digestion\(^{16,45}\).

Grant et al.\(^{46}\) investigated the influence of mealtimes during night shifts on work performance and subjective complaints. They found that a lack of eating at night was correlated with increased hunger and with a significant increase in stomach upsets during the night \((p=0.026)\). Some studies have noted that the higher incidence of peptic ulcers in rotating shift workers may be due to circadian rhythm disorders delaying gastric emptying, increased coffee intake, or increased smoking\(^{47}\). The systematic review conducted by Knutsson and Bøggild also indicated that rotating shift work increases the occurrence of peptic ulcers, but further meta-analysis was not conducted\(^{48}\).

**Conclusion**

Our meta-analysis identified a significantly higher incidence of indigestion and peptic ulcers among rotating shift workers than among fixed day shift workers. Although maintaining regular mealtimes is more difficult for rotating shift workers, it is still suggested that regular eating habits be established as much as possible to reduce the incidence of indigestion or peptic ulcers.

**Limitations and future directions**

A high degree of heterogeneity existed among the studies included in this meta-analysis. The causes of the heterogeneity may be attributed to the age, years of rotating shift work experience, the rotating shift method, and the number of days off. Due to this heterogeneity, we conducted a sensitivity analysis on the combined analysis results, removing one study at a time and examining its impact on the meta-analysis results. We also alternated between the fixed effect model and the random effects model. The directions of the ORs in the subgroup analyses did not change, thereby demonstrating the stability of this meta-analysis.

Studies have indicated that working rotating shifts may increase the risk of indigestion and peptic ulcer; however, these problems are also associated with lifestyle, such as BMI and physical activity. The data compiled in this study indicate that most of the studies examined did not rigorously consider nor control for these interference factors.

Hence, more research is required to answer the question of whether rotating shift work is a direct hazard to gastrointestinal health.

**Author Contributions**

Wen-Pei Chang and Yu-Xuan Peng performed the literature search and helped write the manuscript; Wen-Pei Chang conceived and revised the article; and Wen-Pei Chang and Yu-Xuan Peng approved the final version of the manuscript.

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**Conflicts of Interest**

None.

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