THE ASSOCIATION BETWEEN NIGHT SHIFT WORK AND NUTRITION PATTERNS AMONG NURSES: A LITERATURE REVIEW

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Abstract

The shift work system may affect the temporal distribution of eating and diet quality. The paper aimed at reviewing a body of research examining the associations between night shift work and dietary habits among nurses. Data from the PubMed and Google Schoolar databases, as well as references lists in selected papers were searched. The authors used the following keywords: nurses, shift work, diet, nutrition. Papers published in English or Polish were selected for the review, and as many as 19 papers published in 2000–2017 were eventually identified. The studies varied greatly with respect to the study size, subjects' age and the duration of night shift work. The major problem was the heterogeneity of the tools used for dietary assessment. Self-administered questionnaires were used and analyses were rarely adjusted for confounders. Alcohol consumption was the most frequently analyzed aspect (N = 8 studies), followed by the total energy (N = 7), protein, fat (N = 6), and carbohydrate intake, coffee and fruit consumption (N = 5). The results showed quite a consistent association of night work with higher coffee (caffeine) consumption, as well as lower alcohol, and fruit and vegetables consumption. Few studies also reported more frequent snacks consumption, later time of the last meal, eating at night, meals irregularity, and a poorer diet quality among night shift nurses when compared to the reference. The review showed some poor nutritional habits among nurses working night shifts. However, the topic warrants further attention, owing to the relatively small number of the studies performed so far, and their numerous methodological limitations. Med Pr. 2019;70(3):363–76

Key words: shift work, lifestyle, nurses, circadian rhythms, nutrition, night work

BACKGROUND

About 20% of the workforce in general work night shifts [1]. The shift work system, and night work in particular, is frequently found in health care, due to the 24-h medical service required for hospital patients. Nurses' work frequently involves shift work and night work.

Many epidemiological studies conducted among shift workers have shown a higher risk of chronic diseases, including cardiovascular disease, diabetes, metabolic syndrome or even cancer [2]. Moreover, such conditions as sleep disorders [3] and obesity [4] are more frequently observed among night shift workers than among day workers. Circadian rhythm disruption has been proposed as one of the possible underlying mechanisms [3].

Among the issues closely related to irregular working hours is the irregularity of food consumption. However, this abnormal circadian timing of meals may have adverse effects on the processes of digestion, nutrient absorption, enzyme activity, and metabolism, as well as the sensations of hunger, appetite and satiety [5].

The association between the shift work system and nutrition has been investigated since the mid-1960's. Lowden et al. identified as many as 21 research articles published between 1967–2009 that reported on studies concerning a possible relationship between shift work and dietary habits [6]. They concluded that shift work significantly affected the temporal distribution of eating, diet quality, and energy distribution over the course of the day. The authors of another review covering the

period of 1990–2007 noted that in most of the 7 studies identified (including 2 conducted among nurses) some adverse effects on nutrition were observed, such as more frequent and poor quality meals [7]. The most recent review of research in this field [8] has also pointed out a poorer diet quality among shift workers. The reviews have identified certain methodological limitations of the studies, such as small population samples, the use of less-valid dietary assessment methods, or the lack of comparisons with the non-exposed, reference group of day workers [6,8].

To the best of the authors' knowledge, no review of the studies devoted to the assessment of shift work and night work among nurses, and their nutrition habits, have been performed to date. The shift work of nurses is usually organized according to the fast rotating scheme, and it often involves night work. It can be assumed that the nurses' professional background implies a better understanding of health-related issues, including also those related to healthy diet and nutrition, as compared to that expected in the general population and among blue collar workers performing shift work. Some specific factors, like an insufficient time for rest or stress, may also influence dietary choices in this professional group. Therefore, it can be presumed that the conclusions from the previously reported reviews may not directly apply to nurses.

In the present report, the authors aimed at reviewing the research devoted to the associations between night shift work of nurses and their dietary habits, seeking to determine whether any improper behaviors might be the case.

MATERIAL AND METHODS

The literature review was based on data from the PubMed and Google Scholar databases, as well as on the citations search performed in selected papers. The following combinations of keywords: "nurses and shift work and diet" or "nurses and shift work and nutrition" were used. Papers published in English or Polish were selected for the review, and only those that concerned the differences in nutrition patterns by the system of work among nurses were included. Eventually, as many as 19 publications were identified in this field.

RESULTS

The basic characteristics of the studies that were subject to review, including study design, population size, shift work characteristics, diet characteristics and major findings, are displayed in Table 1.

The studies are presented in chronological order, with the focus on methodological aspects.

The study by Geliebter et al. included 85 subjects: nurses, nurses aids and security personnel [9]. The differences in dietary characteristics were compared between late shift (evening and night) workers and day workers. The study focused on the times and number of main meals, time of the last meal, and whether daily food intake changed since the start of the current shift. The study showed that the late shift workers reported fewer meals than the day workers, and a later hour of the their last daily meal. A trend could also be noted for the late shift workers to eat more since the beginning of the later shift. The analysis included age, years of shift work and smoking as covariates. The study was limited by a small population size and the use of an unvalidated questionnaire. Moreover, the night shift and evening shift workers were combined into 1 category; consequently, the differences in effects between these 2 groups could not be distinguished.

Reeves et al., in their study assessing the dietary habits of 36 subjects who were the male and female staff of nursing homes and hospitals, used 6-day food diaries [10]. The researchers also asked questions about the number of main meals and snacks. The data collected were then analyzed using Diet 5 for Windows, which allows for determining the total energy, carbohydrate, fat and protein intake, as well as alcohol consumption. No differences between the night shift and day workers were observed in terms of the total energy consumption. The night shift workers reported consuming food during night hours while on night duty. Women working night shifts were more likely to consume fewer meals but more snacks per day than day workers. Moreover, they reported drinking more coffee and tea cups per day than female day workers. The study was limited by its small population size and crude comparisons.

The study by Bilski et al. was conducted among 241 female nurses (171 working night shifts), and their dietary habits were evaluated based on a set of questions inquiring about health behaviors during the night shift [11]. The analysis showed that only 9.9% of nurses had a hot meal during the night duty, which was usually some stodgy food, and as many as 9.9% reported drinking only coffee during the night duty. The overall daily coffee consumption was higher among the night shift workers although no statistics were presented. The study was limited by the lack of comparisons between

Table 1. The main characteristics and results of the 19 studies included in the review, analyzing dietary habits according to the shift work status among nurses

Reference	Studied population	System of work/ Shift hours	Dietary assessment tool (validation +/−)	Diet characteristics	Most important results
Geliebter et al. (2000), USA, cross-sectional [9]	hospital workers: nurses, nurses aids, security (men and women, N = 85): – late shift (evening or night) workers (N = 49), mean age: 45.2 years, work duration: 10.1 years, – day workers (N = 36), mean age: 41.6 years, work duration: 7.6 years	3 shift system: – day shift: 8:00 a.m.–4:00 p.m. – evening shift: 4:00 p.m.–12:00 a.m. – night shift: 12:00 a.m.–8:00 a.m.	the original questionnaire inquired about: – the usual time of main meals, including snacks – changes in the above since the start of the current job – changes in daily food intake since the start of the current shift (increase or decrease in energy intake) (−)	usual times of main meals and snacks, changes in daily food intake since the start of the current shift	late shift workers reported: – eating the last main meal at a later hour: 10:27 p.m. vs. 5:52 p.m. (p < 0.005) – consuming fewer meals than day workers (1.9±0.9 vs. 2.5±0.9) (p = 0.002) – consuming more since the beginning of the late shift (p = 0.06) no difference in the number of consumed snacks
Reeves et al. (2004), Great Britain, cross-sectional [10]	staff of the residential nursing homes and hospitals (N = 36 [16 men, 20 women]): – female day workers (N = 10), mean age: 28 years – female night workers (N = 10), mean age: 26 years		6-day diary (the participants were asked to record data about their entire food and drink intake); food intake analyzed in Diet 5 for Windows (Univation, Aberdeen) (+)	consumption of: – total energy (kJ) – carbohydrates (g) – fats (g) – proteins (g) – alcohol (g) – coffee – tea time of consumption over 24 h on the work day and the rest day	intake among night workers vs. day workers (among females): – energy: 6 604 kJ vs. 6 990 kJ (1 577 kcal vs. 1 669 kcal) – carbohydrates: 195 g vs. 188 g – fats: 64 g vs. 108 g – proteins: 52.5 g vs. 53 g – alcohol: 0 g vs. 0 g shift workers: – consume fewer main meals and more snacks (p < 0.05) – drink more coffee and tea (p < 0.01) – eat during the night when working night shift
Bilski (2006), Poland, cross-sectional [11]	hospital nurses working rotating night shifts (women, N = 171), age: 22–50 years (M = 33.5), work duration: 1–31 years (M = 12.5)	12-h two-shift system: – 7:00 a.m.–7:00 p.m. – 7:00 p.m.–7:00 a.m.	the original questionnaire inquired about food behaviors (−)	consumption of : – coffee – hot meal – fruit – tea – sweets	during the night shift: – 7.6% of nurses do not eat any meal – 17.5% drink exclusively coffee – 9.9% eat hot meal – 6.4% eat fruit and drink tea – 3.5% eat sweets with other foods
Zhao et al. (2011), Australia, cross-sectional [12]	nurses and midwives (women, N = 2 494), age: 20–70 years: – day workers (N = 1 259), mean age: 45.1 years – shift workers (N = 1 235), mean age: 41.3 years	categories: – day work (exclusively) – shift work: continuous shift work, evening shifts only, night shifts only, morning and evening shifts only, or evening and night shifts only	online survey; *Australian Recommended Food Score* (ARFS) measured diet quality; 74 items instrument (yes–no); *Semiquantitative Food Frequency Questionnaire* – questions about how often, on average, the respondents drink one glass, bottle, can of beer (heavy) or beer (light), red or white wine, or spirits (e.g., vodka) (+)	diet quality according to ARFS scores: ≤ 24 pts, 25–30 pts, 31–34 pts, 35–39 pts, ≥40 pts – more scores better diet quality, alcohol consumption in categories: – abstain from alcohol – low-risk drinkers – risky drinkers – high-risk drinkers	shift workers, when compared to day workers, were less frequently classified as risky (5.3% vs. 8.7%) or high-risk drinkers (2.5% vs. 3.1%), and they more often abstained from alcohol (18.1% vs. 12.9%) (p = 0.009) no difference in diet quality between day and shift workers (p = 0.747)

Table 1. The main characteristics and results of the 19 studies included in the review, analyzing dietary habits according to the shift work status among nurses – cont.

Reference	Studied population	System of work/ Shift hours	Dietary assessment tool (validation +/–)	Diet characteristics	Most important results
Sahu et al. (2011), India, cross-sectional [13]	hospital nurses (women), N = 75: – shift workers (N = 40), mean age: 41 years – day workers (N = 35), mean age: 40 years	3 shift system: – morning: 7:00 a.m.– 1:00 p.m. – afternoon: 1:00 p.m.– 8:00 p.m. – night: 8:00 p.m.– 7:00 a.m.	diary – the subjects recorded the item of food taken and the approx. quantity of each item consumed during each meal; the quantities of carbohydrates, protein and fat consumed were calculated using the food value table in India (–)	times of main meals (actual vs. preferred): – no meals per day – no snacks per day – appetite consumption of: – total energy (kcal) – carbohydrates (g) – proteins (g) – fats (g) – vitamins (carotene, thiamine, niacin, riboflavin) – calcium (Ca) – iron (Fe)	among shift workers a significant difference between the actual and preferred time of breakfast and dinner (p < 0.005); among night workers during night shift work a lower number of main meals – 1.43 vs. 2.01, when working during the day (p < 0.005), and more snacks (3.63 vs. 2.01); among night shift workers a lower (p < 0.05) than among day workers consumption of: – carbohydrates: 251.2 g vs. 410.8 g – proteins: 65.1 g vs. 99.8 g – fats: 44.3 g vs. 70.4 g – total energy: 1 698 kcal vs. 2 926 kcal no difference for vitamins, Ca and Fe metals consumption
Saksvik-Lehouillier et al. (2012), Norway, cross-sectional [14]	shift workers (men and women, N = 749): – new to night work (N = 322) – work duration < 1 year, mean age: 27.2 years – experienced shift workers (N = 427) – work duration > 6 years, mean age: 36.5 years	3-shift system: morning, afternoon, night	original questionnaire – questions about the usual consumption (in cups) of coffee, cola or tea (with caffeine) per day; *Alcohol Use Disorders Identification Test Consumption* (AUDIT-C) – 3 items concerned with the amounts and frequency of alcohol consumption (+)	caffeine consumption (cups per day – coffee, tea with caffeine, cola); alcohol consumption (score)	experienced nurses, when compared to those new to night work, had a higher consumption of caffeine (cups per day): 3.36 (2.47) vs. 2.40 (2.73), p < 0.01 and a lower AUDIT-C score: 3.54 (1.69) vs. 4.42 (1.72), p < 0.01
Przeor et al. (2013), Poland, cross-sectional [15]	hospital nurses working rotating shifts (women, N = 51): – aged 31–50 years (younger women – YW) (N = 41) – aged 51–65 years (older women – OW) (N = 10)	12-h shift system	3-day diary (the participants recorded the time, kind of meal and quantity consumed), quantity specified with use of a book containing images of products and meals; data analyzed with Dietetyk 2009 software (+)	the number of meals, the consumption of total energy, micro- and macronutrients, and food items	values compared to the recommended: – total energy intake: – YW – 1 802±494 kcal, 81.9% norm – OW – 2 030±601 kcal, 92.3% norm – greater than recommended energy from (in YW and OW, respectively) [%]: – proteins (127.0, 126.5) – fats (120.5, 119.0) – sacharose (105.9, 123.6) – lower than recommended intake (YW, OW) [%]: – fiber (73.8, 79.2) – Mg (90.7, 97.0) – Ca (57.0, 71.7) – K (62.3, 69.6) – Fe (60.0, 60.8) – vitamin D (61.0, 60.3) – greater than recommended intake (YW, OW) [%]: – digestible carbohydrates (156.7, 184.6) – cholesterol (109.7, 118.0) – animal protein (265.6, 303.3)

– fats (101.1, 110.9)
– Na (103.6, 104.2)
– Zn (123.0, 128.9)
– Cu (184.3, 155.0)
– P (174.4, 192.8)
– vitamin A (158.4, 140.1)
– vitamin E (122.9, 231.1)
– vitamin C (101.1, 196.3)
– intake below the recommended (YW, OW) [%]:
  – cereal products (44.2)
  – vegetables (51.5)
  – fruit (43.4)
  – milk and dairy products (30.5, 87.4)
  – fish (70.9)
  – vegetable fats (82)
– intake above the recommended (YW, OW) [%]:
  – meat, poultry (170.7)
  – eggs (198.6)
  – animal fats (149.3)
  – sweets, sugar (244.4)

Authors, year, country, design	Population	Definition / Method	Measured	Results
Kim et al. (2013), South Korea, cross-sectional [16]	nurses (women, N = 9 989): – shift workers (N = 5 287), mean age: 29.2 years, shift work duration: 0.08–38 years – day workers (N = 4 702), mean age: 37.6 years	original questionnaire, questions about dietary habits, i.e., skipping breakfast, lunch, dinner, drinking alcohol ("regular" defined as more than once per month) (–)	regular alcohol drinking if > 1 per month; skipping: – breakfast – lunch – dinner	regular alcohol drinking more often reported among shift workers (53.5% vs. 42.9%) (p < 0.001), but a decreasing trend of alcohol drinking by shift work duration (p < 0.001); skipping: – breakfast – more often reported among shift workers (43.1% vs. 29.2%), a decreasing trend with shift work duration (p < 0.001) – lunch – more often reported among shift workers (2.0% vs. 0.5%), p < 0.001, a decreasing trend with shift work duration (p < 0.001) – dinner – a decreasing trend with shift work duration (p < 0.001)
Naghashpour (2013), Iran, cross-sectional [17]	nurses (women, N = 98): – shift workers (N = 43), mean age: 33 years – day workers (N = 55), mean age: 33 years	shift work defined as outside hours: 8:00 a.m.–4:00 p.m. — 3-day 24-h recall (2 working days and 1 day off – recorded time, the kind of food and quantity consumed); data verified by a nutritionist and analyzed with Iranian Food Processor software (the Iranian Institute of Nutrition Research and Food Industry) (+)	daily consumption of: – total energy (kcal) – vitamins: thiamin, riboflavin, niacin, pyridoxine, cobalamin, folate, ascorbate, tocopherol, retinol, cholecalciferol – magnesium, calcium, zinc, iron	among shift workers a lower daily consumption (p < 0.05) of thiamin, riboflavin, niacin, folates, magnesium, iron; no significant difference observed for the total energy intake, and remaining vitamins and nutrients
Tada (2014), Japan, cross-sectional [18]	nurses (women, N = 2 758), age: 20–59 years: – shift workers (N = 1 579), mean age: 41.1 years – day workers (N = 1 179), mean age: 42.1 years	Semiquantitative Food Frequency Questionnaire – dietary intake over the previous month; data analyzed with Excel Eiyokun Food Frefency Questionnaires (+)	daily intake of: – food products – total energy – proteins – fats – carbohydrates	night shift workers consumed significantly (p < 0.05) more confectionaries, sweetened beverages alcohol; along with fewer potatoes, starches, green and yellow vegetables, fruit, algae, fish and shellfish, meat and protein; no significant difference observed for the intake of total energy, fats and carbohydrates

Table 1. The main characteristics and results of the 19 studies included in the review, analyzing dietary habits according to the shift work status among nurses – cont.

Reference	Studied population	System of work/ Shift hours	Dietary assessment tool (validation +/–)	Diet characteristics	Most important results
Buchvold et al. (2015), Norway, cross-sectional [19]	nurses (men and women, N = 2 059): – did not work night shift in the previous year (N = 568), mean age: 34.9 years – 1–30 night shift in the previous year (N = 860), mean age: 32.4 years – > 30 night shifts in the previous year (N = 631), mean age: 32.4 years		original questionnaire, questions about the usual consumption (in cups) of coffee, cola or tea (with caffeine) per day; AUDIT-C – 3 items concerned with the amounts and frequency of alcohol consumption (+)	caffeine consumption (cups per day – coffee, tea with caffeine, cola); alcohol consumption (AUDIT-C SCORE)	alcohol consumption lower among nurses with shift work duration > 5 years (β = –0.52, p < 0.05); the number of night shifts in the previous year associated with a greater caffeine consumption (OR = 1.00, 95% CI: 1.00–1.01)
Ramin et al. (2015), US, cohort [20]	nurses (women, N = 54 724), age: 25–42 years: – never work night shift (N = 15 391) – ever work night shift (N = 39 333)	night shift: 11:00 p.m.–7:00 a.m. the staff ever working at night defined as nurses working rotating night shifts or permanent nights	Semiquantitative Food Frequency Questionnaire – 130 items; dietary consumption of alcohol, caffeine and total energy consumption assessed in 2007 (+)	caffeine consumption ≥ 131 mg/day, total calories intake ≥ 1 715 kcal/day, alcohol consumption (g/day)	among the staff ever working at night when compared to those who never work at night: – greater caffeine intake: 184 mg/d vs. 167 mg/d (p < 0.0011, OR: 1.16 (1.12–1.22)) – higher total calories intake: 1 882 kcal/day vs. 1 722 kcal/day (p < 0.0011, OR:1.09 (1.04–1.13)) no difference for alcohol consumption: 6.3 g/day vs. 6.3 g/day
Yoshizaki et al. (2016), Japan, cross-sectional [21]	nurses (women, N = 171), age: 19–63 years: – night shift workers (2- or 3-shift system) (N = 123) – day workers (N = 39)	day work: 8:30 a.m.–5:15 p.m. night work: – 2 shifts: 8:30 a.m.–5:15 p.m., 4:30 p.m.–9:15 a.m. – 3 shifts: 8:30 a.m.–5:15 p.m., 4:30 p.m.–1:00 a.m., 0:45 a.m.–9:45 a.m.	Eating Behavior Questionnaire (Japan Society for the Study of Obesity) – 55 items (+)	eating behaviors: – motivation for eating – eating as a diversion – feeling of satiety – eating style – meal contents – temporal eating patterns	among night shift workers poorer eating behavior with respect to: – meal contents – temporal eating patterns p < 0.05 in the univariate analyses, insignificant results in the multivariate analysis including chronotype
Hakim et al. (2016), Egypt, cross-sectional [22]	nurses (women, N = 400), age: < 40 years (82%)		original questionnaire; 10 questions regarding the average intake of selected foods per week (–)	types of diet: "healthy," "semi-healthy," "unhealthy"	"unhealthy diet" observed more often among nurses working night shifts > 10 years (13.6%) than among those working < 5 years (6.8%) and 5–10 years (6.9%) (p = 0.004)
Gladysz et al. (2016), Poland, cross-sectional [23]	– hospital nurses (women, N = 140), mean age: 34.3 years, including 109 shift workers	day work 8-h or 12-h shift system (12 h): – 7:00 a.m.–7:00 p.m. – 7:00 p.m.–7:00 a.m.	original questionnaire (tested in pilot), questions about nutritional behavior (+/–)	meals pattern: – no meals/day – no meals at work – no meals at night – meals regularity	no differences observed for the number of meals per day, longer shift work related to a greater number of meals consumed per day (p < 0.001) and eating at night shift (p = 0.046)
Almajwal (2016), Saudi Arabia, cross-sectional [24]	nurses (women and men, N = 395), age < 40 years (68.6%): – working night shift (N = 258) – day workers (N = 137)		Dutch Eating Behaviour Questionnaire (DEBQ) – 33 items measuring unhealthy eating behaviors; the frequency of eating fast foods and snacks, the number	eating style: – "restrained" – "emotional" – "external" the frequency of eating	night shift associated with "restrained eating" (OR = 1.53, p = 0.029) and "external eating" (OR = 0.55, p = 0.026); higher frequency of the night shifts 4–7/month, and >7/month associated with "restrained" (OR = 2.13, OR = 1.89) and "emotional"

Study	Shifts	Population	Assessment tool	Outcomes measured	Results
			of servings of fruit and vegetables, and serving sizes; Binge eating (+)	fast food, binge, snacks, and fruit and vegetables	eating (OR = 1.48); binge and fast food eating more frequent among shift workers
Han et al. (2016), South Korea, cross-sectional [25]	8-h shifts	nurses (women, N = 340), mean age: 30 years: – rotating night shifts (N = 252) – rotating shifts (no nights) (N = 35) – day workers (N = 53)	original questionnaire; questions about usual dietary behaviors (−)	dietary behaviors, the number of meals per day, snacks, meals regularity, skipping breakfast, overeating, the frequency of fruit and vegetables consumption	night shift workers, when compared to those working shifts but not night shifts and day workers, showed: – more frequent meals irregularity: 86.9% vs. 65.7% and 37.7 – breakfast skipping: 41% vs. 26% and 26% – eating snacks at night: 44% vs. 25.7% and 5.7% – less frequent consumption of 3 meals per day: 21% vs. 40% and 55% – fruit and vegetables consumption > 1 portion per day: 54% vs. 77% and 62%
Beebe et al. (2017), USA, cross-sectional [26]		nurses (women, N = 103), mean age: 38.8 years: – night workers (N = 53) – day workers (N = 50)	Food Frequency Questionnaire (134 food items, 8 supplements); Diet History Questionnaire II (DHQ II) (The National Cancer Institute, 2016) (+)	diet quality, eating fruit, vegetables, greens and beans, dairy, total protein foods, seafood and plant proteins, fatty acids, grains, sodium, empty calories	no significant differences observed between the compared groups
Roskoden et al. (2017), Germany, cross-sectional [27]		workers of the Medical University Department (men and women, N = 44): – night shift nurses (N = 23), mean age: 31 years – day workers (N = 21), mean age: 41.6 years	7 days diary (times, kind and amount of consumed food); data analyzed by OptiDiet software (+)	total energy, macro and micronutrients consumption	A significantly lower fats and significantly higher carbohydrates consumption among nurses working night shifts, compared to clerks

night shift and day workers. Moreover, the questionnaire used was developed by the researchers themselves and no information on its validation was provided.

Zhao et al. analyzed diet quality and alcohol consumption in an e-cohort of 2494 nurses and midwives [12]. Diet quality was measured using *Australian Recommended Food Score* (ARFS), which is a 74-item validated instrument. The average alcohol consumption was assessed with semiquantitative FFQ, and the subjects were classified into 4 categories: abstaining from alcohol, low-risk drinkers, risky drinkers and high-risk drinkers. The analysis showed no differences in diet quality between the day and shift workers. The latter more frequently reported abstaining from alcohol, and were less frequently classified as risky or high-risk drinkers. The difference in the distribution was statistically significant, and the analysis was adjusted for age.

A group of 40 female hospital nurses and 35 day working nurses were studied in India [13]. Their dietary habits were assessed based on data from diaries in which the subjects recorded the specific food items and amounts consumed. Food value tables were used to calculate total energy, protein and carbohydrate intake, as well as some vitamin and mineral intake. The average values of the last 2 items were calculated on the basis of 15 days consumption data. According to the study results, the night shift workers reported to consume fewer main meals but more snacks during the day with the night duty, when compared to the day workers. They were also found to have a lower energy, protein, fat and carbohydrate intake. No difference was observed for vitamin or mineral consumption. The subjects in both groups were of similar age, and the night shift workers were slightly slimmer than the day workers. Only crude analyses were performed in this study.

A population of 749 Norwegian nurses working night shifts was investigated by Saksvik-Lehouillier et al. [14]. The study population included 322 women with less than 1 year of experience in night shift work and 427 with over 6 years of respective experience. During the study, the researchers inquired about the number of coffee, coke or tea cups usually consumed daily. Alcohol consumption was measured with *Alcohol Use Disorders Identification Test Consumption* (AUDIT-C), a validated tool. The crude comparison performed showed a significantly higher coffee consumption and a lower AUDIT-C score among more experienced nurses.

A cross-sectional study on a population of 51 hospital nurses working night shifts was carried out in Poland [15]. The nurses completed a diary reporting their food consumption over a 3-day period: before the night duty, during the duty and on the day off. The dietary data (total energy, daily macro- and micronutrient consumption) were analyzed with computer software. The study results revealed lower than recommended values of the total energy consumption, and those of fiber, Ca, Mg, Fe, K, vitamin D, folic acid, and fluid intake, and a higher intake of animal proteins, fat, cholesterol, Na, P, Zn, Cu, and vitamins A, E, B and C. This finding was associated with a lower consumption of cereals, fruit, vegetable, dairy products, processed meat products, fish, and vegetable fats, and a higher than recommended consumption of meat, poultry, eggs, animal fats, sweets, and sugar. In this study, no formal reference group was established. Instead, the calculated values were compared with recommended standards, and the results indicated potential disparities. The findings pointed to a lower than recommended energy intake, but at the same time, the BMI for some subjects was at the upper limit value or even indicated overweight, which would imply a dietary underreporting.

A large cross-sectional study of 9989 Korean nurses was carried out by Kim et al., who used the web-based survey [16]. A self-administered questionnaire included questions on alcohol consumption and dietary habits. Night shift nurses reported a higher consumption of alcohol when compared to day workers, but the frequency of a regular drinking habit decreased with an increasing duration of shift work. The shift work nurses more frequently reported skipping breakfast and/or lunch, but this tendency was found to significantly decrease with an increasing duration of shift work. The crude analyses performed did not include any adjustments for covariates.

The cross-sectional study to assess dietary habits among 98 Iranian hospital nurses employed 24-h recalls of a 3-day period [17]. The dietary data were verified by a nutritionist. The total energy, vitamin and micronutrient intakes were calculated. The data analysis showed that shift workers consumed less thiamin, riboflavin, niacin, folates, magnesium, and iron. No differences between the shift and day workers were observed with respect to daily consumption of total energy, pyridoxine, cobalamin, ascorbate, tocopherol, retinol, cholecalciferol, zinc, and calcium. The crude means were compared using Student's t-test.

Dietary intake over a 1-month period was evaluated in a cross-sectional study of 2758 nurses in Japan [18]. In this study, a semiquantitative food frequency questionnaire was used and total energy consumption, as well as

product groups and nutritional elements, were evaluated. Women working shifts reported a higher consumption of sweets, sugar-sweetened beverages and alcohol, and a lower consumption of potatoes and starch, green and yellow vegetables, white vegetables, fruit, algae, fish and shellfish, and meat. Protein consumption was significantly lower among the shift workers, but no difference was observed for the intake of total energy, fats and carbohydrates. The analysis was adjusted for total calories intake.

A cross-sectional study of 2259 Norwegian nurses investigated the association between night shift work duration (> 5 years vs. < 5 years) and its intensity, expressed as the number of night shifts over the previous year, and daily caffeine consumption and alcohol consumption [19]. Alcohol consumption was measured using AUDIT-C. The study found a statistically significant inverse association between a longer duration of night shift and alcohol consumption. A higher number of night duties during the year preceding the study was significantly associated with coffee consumption. The multivariate analysis included age, gender, the average number of working hours and cohabitating children as covariates.

In a large Nurses Health II cohort study of 54 725 women (39 333 ever working night shifts), the authors examined the association between shift work and total energy intake, as well as coffee and alcohol consumption [20]. Dietary data were collected via a validated semiquantitative food frequency questionnaire covering 130 food items. For the logistic regression analysis, the total energy consumption was classified into 2 categories: ≥ 1712 kcal/day and < 1712 kcal/day, and coffee consumption ≥ 131 mg/day and < 131 kcal/day. The analysis showed a statistically significant association between higher calories and coffee consumption, and ever working night shifts. The multivariate analysis included a number of covariates, such as age, partner's education, smoking, physical activity chronotype, and BMI. The basic characteristics of the study population did not show any differences in alcohol consumption due to the night shift status.

Yoshizaki et al. investigated dietary habits in a group of 162 nurses (including 123 working night shifts) [21]. The dietary behaviors were measured with the self-administered questionnaire. The questionnaire used was developed by the Japan Society for the Study of Obesity and employed a scoring system for the measurement of obesity-related behaviors such as cognition of constitution, motivation for eating, eating as a diversion, feeling of satiety, eating style, meal contents and temporal eating patterns. The crude data analysis showed that the night shift workers had a more unbalanced diet with a greater preference for high-fat diet and sweets, and an abnormal eating pattern, including a greater irregularity in the timing and number of meals, and later time of meals. The multivariate analysis that included age, marital status, residential status, smoking, alcohol status, and the number of night shifts during the previous month revealed an association with the chronotype but not with the night shift work.

Hakim et al. investigated nutritional behaviors among 400 nurses, considering the duration of night shift work [22]. They used a 10-item questionnaire to inquire about the usual frequency of particular food item consumption per week. Dietary data were analyzed based on the scoring system, categorizing women into 3 groups of 'healthy,' 'semi-healthy' and 'unhealthy' diet. The crude analysis of group distribution according to shift work duration showed a more frequent 'unhealthy' diet in the group of nurses working night shifts for a period of more than 10 years. These differences were not statistically significant.

The nurses' dietary habits at the workplace were examined in a study of 140 hospital nurses in Poland (including 109 shift work nurses) [23]. In this study, a questionnaire developed by the study authors was used to elicit data on the number of meals per day, the number of meals while at work, main meals, meals regularity, and eating at night. Nurses with a history of night shift work of more than 20 years reported consuming more meals per day than the nurses who had a shorter history of night shift work. Nurses working night shifts and those who had a 12-h duty but only during the day, were more frequently found to have meals at night than the nurses who had a 8-h day time duty. The findings were analyzed using crude χ^2 test unadjusted for any covariates.

A population of 395 nursing staff at 2 hospitals in Saudi Arabia was investigated in a cross-sectional study by Ajmawal [24]. *The Dutch Eating Behaviour Questionnaire*, a validated tool comprising 33 questions, was used to categorize subjects into the following categories: restrained (a tendency to restrict food intake to control body weight), emotional (to cope with negative emotions) and external eating (the extent to which external cues of food trigger the eating episodes). The author found a statistically significant positive association between night shift work, particularly a higher frequency of night shifts per month, and restrictive or emotional

eating, and an inverse association with external eating. The analyses included age, gender, education, and marital status as covariates.

Han et al. conducted a cross-sectional study of 340 nurses in South Korea, evaluating their dietary behaviors, the number of main meals, snacks, meals irregularity, skipping breakfast, overeating, and the frequency of fruit and vegetable consumption [25]. The questionnaire inquired about the items that matched the recommendations of the Korean Dietary Guidelines. The night shift workers more frequently than the day workers reported meals irregularity, skipping breakfast, and eating snacks at night, while less frequently eating 3 main meals per day and more fruit servings per day. The crude comparisons did not include any covariates.

Diet quality and night shift work were evaluated among 103 hospital nurses in the USA (53 working night shifts) [26]. *Diet History Questionnaire II* (DHQII) developed by the National Cancer Institute was used to ask questions about the frequency and amount of consumption of 134 food items and 8 dietary supplements over a period of one month preceding the study. The findings revealed no differences in diet quality of the night shift nurses when compared to the day nurses. The crude analysis did not account for any covariates.

Nutritional habits were evaluated in a small group (N = 46) of medical university staff (23 nursing staff working night shifts, 10 nurses working during the days, and 13 clerical staff) in Germany [27]. The information about the foods consumed was collected via diaries covering a 7-day period. Data were analyzed with OptiDiet software to calculate macro- and micronutrient intake. In this study, no differences in the total energy intake were found between night shift and day workers. Both the nurses working night shifts and those working only during days consumed significantly less fats than did the clerical staff. Carbohydrate intake among the night shift nurses was significantly higher than among the office staff, but not when compared to the day nurses. No covariates were included in the crude analyses of the data.

CONCLUSIONS

The aim of the present review was to evaluate the existing epidemiological data on the association between shift work, with special regard to night shift work, and the nutritional habits of nurses working according to that pattern. The authors have identified altogether as many as 19 papers describing studies in this area, which were published in 2000–2017. The total number of studies

in this field is relatively small, but an increasing interest has been noted over the last decade, and as many as 16 of the 19 papers identified have been published since 2011.

The studies varied greatly with respect to the size and age of the study populations, and the duration of night shift work. The major problem which could be identified is the heterogeneity of the tools used for dietary assessment. Therefore, the data aggregation, as well as direct comparisons and meta-analyses, are precluded at this stage.

Table 2 presents the findings of the studies reviewed, by the dietary items or behaviors examined, providing the number of studies that evaluated a specific item, and referencing the studies that found the consumption higher, lower or equal among shift work nurses when compared to the reference. Alcohol consumption was the most frequently analyzed (8 studies), followed by the total energy (7 studies), protein, fat (6 studies), and carbohydrate intake, as well as coffee and fruit consumption which were evaluated in 5 studies, i.e., in about one-third of the studies covered by this review. The other food items were examined even less frequently.

The results were fully consistent with respect to coffee (caffeine) consumption, indicating a more frequent or higher coffee consumption among the nursing staff working night shifts [10,11,14,19,20]. Coffee consumption seems to be related to a longer duration and a higher frequency of night shift work [14,19]. Two studies reported the consumption of more than 3 cups of caffeine drinks per day as being related to both a higher number of the night duties worked in the previous year and to night shift work seniority [19,28]. Dietary recommendations generally accept coffee consumption of up to 3 cups per day. Coffee helps overcome sleepiness and fatigue, and this may explain its higher consumption among night workers. The recent umbrella review of the observational and interventional studies of coffee consumption and any health outcomes has concluded that coffee drinking seems safe within the usual patterns of consumption except for pregnant women and women with an increased risk of fractures [29]. It should be borne in mind that the drinks containing coffee or caffeine may disturb the sleep pattern [30], with frequent awakenings and prolonged sleep latency. Thus, the sleep effectiveness and night work tolerance may decrease in the long run.

Given the increasing evidence on a higher risk of obesity among night shift workers, the data on the total energy intake are of particular interest. Among

Table 2. Food items from observational studies analyzing dietary habits according to the shift work status of nurses

Dietary characteristic	Reference			Studies [n]
	+	–	no difference	
Total energy	20	13, 15	10, 17, 18, 27	7
Proteins	15	13, 18	10, 26, 27	6
Fats	15	13, 27	10, 18, 26	6
Carbohydrates	15, 27	13	10, 18	5
Cereal products		15	18, 26	3
Potatoes, starches		18		1
Pulses			18, 26	2
Nuts, seeds			18	1
Algae		18		1
Fish and shellfish		18	26	1
Eggs	15		18	2
Dairy products			18, 26	2
Sweets	15, 18		26	3
Vitamins	15 (A, E, B1, B2, B6, PP, C, folic acid)	17 (B1, B2, B3, folates)	13, 17 (B6, B12, C, E, retinol, D)	3
Iron		15, 17		2
Magnesium		15, 17		2
Calcium		15, 17		2
Zinc	15		17	2
Red meat	15	18		2
Alcohol	16, 18	12, 14, 16[a], 19	10, 20	8
Tea	10			1
Coffee (caffeine)	10, 11, 14, 19, 20			5
Fruit		15, 18, 24*, 25	26	5
Vegetables		15, 18, 24	26	4
Sweetened beverages	18			1
Salt	15		18, 26	3
Number of main meals	23 (number of meals at work – 18)	9, 10, 13		4
Number of snacks	10, 13, 25		9	4
Meals regularity		16, 25		2
Time of the last meal	9 (later), 21			2
Eating at night	10, 21, 23			3
Diet quality		21, 22 (worse)	12, 20, 26	5
Dietary habits change since the start of shift work	9 (meals intake increase)			1

[a] Among shift workers with longer shift work duration.
* In the subgroup of emotional eating.
"+" – greater consumption compared to the reference group.
"–" – lower consumption compared to the reference group.

the 7 studies that evaluated the total energy intake by the shift work status, 4 studies reported no difference [10,17,18,26,27], 1 reported a higher energy consump- tion among shift workers [20] and 2 indicated a lower consumption [13,15]. Most of these studies were small- scale, and thus they may have been underpowered to

elucidate the true inferences [10,13,15,17,27]. Of the 2 large and good-quality studies, 1 reported a positive association between "ever" working night shift and a higher total energy consumption [20], while the other revealed no difference for the current work schedule [18]. The differences in the definitions of exposure adopted in these studies, as well as those in ethnicity of the study population, could potentially explain the observed inconsistency in the study findings.

In addition, 2 out of 3 studies indicated a higher consumption of sweets or sweetened drinks [15,18], which could be related to the higher carbohydrate intake reported in 2 studies [15,27]. It has to be noticed, however, that in 2 out of 5 studies in total, where this parameter was calculated, no differences attributed to the system of work [10,18], or even a lower carbohydrates intake [13] among the night shift workers, were found. The findings of a single small-scale study showed that shift workers reported eating more since the beginning of the later shift [9], but this observation was not replicated in other studies. For the body weight regulation, some other aspects, apart from the total energy intake, may also play a role. These include diet quality and composition, and temporal distribution of foods. Five of the studies analyzed diet quality [12,20–22,26] using various questionnaire tools and guidelines. A poorer diet quality among night shift nurses was found in 2 studies [21,22], while 3 others revealed no differences in the analyses by the system of work [12,20,26]. Few studies indicated the specific aspects of poor dietary behaviors of nurses working night shifts, such as a lower number of main meals per day [9,10,13], meals irregularity [16,25], a later hour of the last meal [9,21], and eating at night [10,23]. Similar problems have been indicated among shift workers in industry [6,7].

Although the number of studies that examined the intake of fruit and vegetables was relatively small, most of them reported lower consumption among night shift workers as compared to the reference [15,18,24, 25]. This adds to a poorer diet quality of the night shift workers.

There was a good consistency of the study results regarding alcohol consumption, which was found to be lower among night shift workers when compared to day workers [12,14,16,19]. Also, the duration of shift work tended to be associated with a lower alcohol consumption [14,16,19].

The intake of vitamins and microelements such as iron, magnesium, zinc, and calcium, was rarely evaluated. Two of such studies reported a lower intake among nurses working night shifts as compared to the reference group [15,17]. These results derive from small-scale studies that employed the method of completing a diary on the foods consumed over a given period. Therefore, further studies are warranted to confirm these findings.

Methodological issues

The studies focused on the association between shift (night) work of nurses and their nutrition patterns had a cross-sectional design. While cross-sectional studies provide a good picture of the health care needs of the population at a particular point in time, their value in investigating etiological relationships is limited since the time sequence is unknown.

In the majority of the studies, the nursing staff have been investigated. In 2 studies [9,27], the populations were more heterogeneous, including nurses aids, security staff [9] and clerks [27]. As many as 13 out of 19 studies included only women, and 6 studies included subjects of both genders [9,10,14,19,24,27]. There were 6 small-scale studies, i.e., of less than 50 subjects per group [9,10,13,15,17,27], while 8 studies included from several dozen up to 1000 subjects [11,14,21–26]. There were 4 studies examining relatively large populations of several thousand people [12,16,18,19], and in 1 study, the population size was very large, of over 1000 [20].

The instruments used for dietary assessment are briefly characterized. In all the studies, the questionnaires were self-administered, which implies a possibility of some inaccuracies and underreporting [31]. Measurement error is inherent in any self-reported dietary assessment [32]. There was a large heterogeneity of the questionnaires used. The *Food Frequency Questionnaire* was used in 4 studies [12,18,20,26]. This tool aims at assessing the usual diet, and is much more precise than diaries. The diary method covering the periods from 3 days up to 15 days [13] was used in 5 studies [10,13,15,17,27]. Dietary diaries in which the subjects record the timing and food items consumed shortly after the meal were demonstrated to be reliable and valid tools [33]. However, they may not represent the usual diet, especially when covering a smaller number of days, and they do not consider seasonality.

Most frequently, the questionnaires developed by the authors of the research themselves were used [9, 11,14,16,19,22,23,25]. In most cases, the tools were validated, but in the case of 6 studies, the validation was either not described or not performed [9,11,13,16, 22,25].

It also has to be underlined that the analyses performed for the studies were usually not controlled for confounders. In fact, the adjusted analyses with control for various confounders were carried out only in 5 studies [18–21,24].

To conclude, the existing epidemiological evidence on the relationship between night shift work of nurses and their dietary habits is inadequate to draw any definite conclusions. The number of studies performed has been relatively small, and some methodological issues have not been properly addressed thus far. The picture is further complicated by the inconsistency of the results. However, the findings of the present review indicate that the major problem among nurses working night shifts may be a higher than usual coffee consumption, along with meals irregularity and improper timing that is inconsistent with the circadian clock. Further studies in this area are warranted, in particular on larger populations and using validated tools for the dietary assessment.

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