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NIGHT SHIFT AND 25-HYDROXY VITAMIN D3 STATUS AMONG HOSPITAL NURSING STAFF

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Abstract

Introduction: Working with night shift system can have a substantial negative influence on the worker's physical, psychological, and mental health as well as their ability to accomplish their professional duties. Vitamin D insufficiency is a worldwide problem. It has a negative impact on the health of those who are vulnerable. It is hypothesized that night work may affect circulating vitamin D3 levels due to reduced exposure to direct sunlight. **Aim of Work:** to elucidate the relation between night shift work and 25-hydroxy vitamin D3 status among hospital nursing staff **Materials and Methods:** It is a cross-sectional comparative study on the nursing staff working in hospitals in Ismailia. The participants' number was150 individuals (who included night shift, day shift and rotating shift workers), a questionnaire was addressed including: personal data, occupational history, nightshift work characteristics, food description of vitamin D2 intake sources ,Index of exposure to sunlight. The level of 25-hydroxyvitamin D3 in the blood serum was measured. **Results:** The study showed that 44% of night shift and 38% of rotating shift nursing staff were deficient in 25-hydroxyvitamin D3, 38% of night shift and 46% of day shift nursing staff were insufficient, while only 34% of day shift were sufficient. The results revealed a significant difference in serum vitamin D3 levels between nursing staff groups ($p<0.005$). The day shift staff median serum vitamin D3 level was 18 (15, 24) ng/ml, while the night shift staff median level was 13 (9, 17) ng/ml. The number of night shifts worked per month, per year, and taking a sleep during the night shift were all predictors of vitamin D3 deficiency. **Conclusion:** individuals who work the night and rotating shifts had lower levels of vitamin D3 than those who solely work the day shift. **Recommendations:** Health education about sun exposure guidelines and vitamin D food sources is recommended for night and rotating shift nursing staff and also indoor workers. Nursing staff should be encouraged to

take breaks to go outdoors for sunlight exposure and to consume adequate amounts of vitamin D-rich foods; and vitamin D supplements to maintain optimal vitamin D levels.
Keywords: Night Shift, Vitamin D deficiency, 25-Hydroxy Vitamin D3 and Nursing staff.

Introduction

Shift work can be defined as the organization of working time by different teams in succession to cover more than the usual 8-hours workday, up to a 24-hours period. The major reason for shift work is that; modern technology has made it possible to do many activities at any time of the day or night. This "24-hours society" requires that important services be provided at all the times (Potter and Wood, 2020).

Night shift work and inadequate sleep decrease performance, including the capacity to focus, the ability to respond quickly, and the ability to recall and acquire new information and motor skills. Sleep deprivation also causes impatience, a foul mood, poor communication skills, and an inability to cope with the intellectual requirements of the workplace, as well as a decline in decision-making capacity and an increase in risk-taking behavior(Banks and Dinges, 2007). Hospitals recruit more night shift employees than any other profession. Working the night shift may have a considerable negative impact on a worker›s physical, psychological, and social wellbeing, as well as his or her professional performance(Ferri et al., 2016).

Vitamin D3 is a fat-soluble vitamin that is gained naturally from sun exposure, diet, and pharmaceutical supplementation. It improves calcium absorption from the colon and keeps serum calcium and phosphate concentrations appropriate for proper bone mineralization. The serum 25-hydroxy vitamin D3 biochemical evaluation is the most appropriate method of measuring vitamin D3. For healthy persons, a level of 20 nanograms/milliliter to 50 ng/mL is considered appropriate. A vitamin D3 deficiency is diagnosed when the level falls below 12 ng/mL (Christine, 2018).

Vitamin D3 insufficiency is a common medical problem all over the world. Despite the importance of sunshine in vitamin D3 synthesis, recent research has indicated that the rate of vitamin D3 insufficiency is even greater in the sunniest places of

the world, including the Middle East countries such as Saudi Arabia and Qatar, particularly in females due to cultural reasons. It is also common in western nations such as America and Europe, however it varies according on the season and age group (Palacios and Gonzalez, 2015).

The growing number of employed people who are suffering from vitamin D3 insufficiency has implications for health, resulting in cost and performance and an economic burden in whole(Coppeta et al., 2018).

In Egypt, published data focused on vitamin D3 deficiency among mothers and children since they are considered vulnerable populations; there was minimal interest in vitamin D3 status among the working population. Theoretical links between vitamin D3 insufficiency and working situations, such as shift work, have been identified.

Aim of Work

To elucidate the relation between night shift work and 25-hydroxy vitamin D_3 status among hospital nursing staff.

Materials and Methods

Study Design: It is a cross-sectional comparative study design to study the relation between night shift work and 25-hydroxy vitamin D_3 status.

Place and duration of the study: A period of around 6 months was taken to collect the data from working nursing staff in Suez Canal University Hospital and Ismailia Medical Complex, Ministry of Health and Population from August 2019 to February 2020.

Study sample. Sample size was calculated based on mean of Vitamin D in the studied groups (night shift or rotating shift) = 13.4ng/mL, and mean in the comparative(day shift) group =21.9 ng/mL (Romano et al., 2015). So, by calculation, the sample size will be 50 for each group, for a total sample size of 150 participants. Day shift nurses: these were nurses that only worked throughout the day. Night shift staff group: these were nurses who solely worked night shifts from 8 to 12 hours after 10 p.m. for at least one month (Saksvik-Lehouillier et al., 2015). Rotating shift staffing: At least three nights each month in addition to the 19 days and afternoons in that month) (Vetter et al., 2018).

The total number of nursing staff in Suez Canal University Hospital and Ismailia Medical Complex, Ministry of Health was 2200 individuals. Night shift nursing staff was 400 and present

in Internal medicine, Cardiology, and Surgery departments. Rotating shift nursing staff was 900 and present in Obstetrics and Gynecology and Pediatrics departments while the day shift nursing staff was 600 and present in all departments. Non-proportionate stratified random sampling according to shift type as we made sampling frame for each shift type then randomly, 50 nurses were chosen in each subgroup.

Inclusion criteria: nursing staff either male or females hired for at least 1 year before the study recruitment. Exclusion criteria: nurses received vitamin D or calcium supplementation the past two months, diagnosed with endocrine diseases, had surgical intervention for thyroid gland and diagnosed with renal and liver diseases.

Study methods:

1-**Questionnaire:** which was a self-administrated including personal, occupational, and medical histories. Dietary description for food intake of vitamin D_2 sources like dairy products , fish and eggs was recalled for a week duration by amount and frequency for each item, like number of milk cups per day throughout the week, then it was multiplied with the content of vitamin D for each food to make sure that the nursing staff take sufficient food sources as they receive meals from the hospital for shift work (Aborhyem, et al.2020). Taking into consideration that breakfast and dinner meals introduced in the hospital rich in vitamin D sources like eggs and milk.

2-**Measurements:** includes **Body Mass Index** (BMI) according to equation BMI=

and **Sun Exposure Index** for vitamin D through the four sun exposure guidelines: staying in shade, using a sunhat, wear clothing that covers the torso, upper arms, and thighs, and applying sunscreen. Each question had four alternative answers: “Always,” “Frequently,” “Occasionally,” and “NO.” Then each one of the four criteria which are staying in shade, face covering, wear protective clothing and applying sunscreen were recoded into the form of Yes/NO questions; Yes for the answers of “Always,” “Frequently,” and NO for “ Occasionally,” and “NO” (with five categories ranging from 0 (completed 0 of the sun exposure standards) to 4 (completed 4 guidelines).

Individuals with higher scores (fulfilled more than 2 categories) are more likely to have less sun exposure (Hansen et al., 2016)3194 Danes (2625

adults, 569 children.

3-Laboratory assessment:

The studied individuals were subjected to blood sampling (4 ml) for serum 25- hydroxyvitamin D assessment by competitive electrochemiluminescence immunoassay.

The serum 25-hydroxyvitamin D testing results were interpreted as follows:

• For healthy adults, a level of 20 to 50 ng/mL was considered appropriate.

• Vitamin D insufficiency is indicated by a level less than 20 ng/mL and greater than 12 ng/mL.

• Vitamin D deficiency is indicated by a level less than 12 ng/mL. (Christine, 2018).

Consent

All subjects participated in the study gave informed consents after appropriate clarification regarding confidentiality of data and aim of the study.

Ethical Approval

The approval of medical research committee of Faculty of Medicine, Suez Canal University was obtained and complied with local legislation and the Helsinki Declaration (code: 3814/4/2019).

Data Management

SPSS version 23 was used to enter and evaluate the data. When comparing more than three non-parametric data groups, the Kruskal-Wallis test was used. A post-hoc test was carried out. The chi-squared-test ($\chi 2$) was performed to compare qualitative data groupings. Multiple logistic regression using the backwards stepwise technique was performed to determine the predictors of vitamin D_3 deficiency. A p-value of less than 0.05 was considered significant for statistical significance.

Results

The study included150 nurses who were working in both Suez Canal University Hospitals and Ismailia Medical Complex (Previously: Ismailia General Hospital). They were recruited as three equal groups; 50 nurses were working in the Day shift, 50 in the Night shift, and 50 were working under the rotating shifts system.

Table 1. Comparison of sociodemographic characteristics of the studied sample (No= 150):

	Day shift staff[1] **No. (%)**	**Night shift staff[2]** **No. (%)**	**Rotating shift staff [3]** **No. (%)**	**p- value**
Age/years				
20-	16 (32.0)	46 (92.0)	33 (66.0)	**0.001*[b]**
30-	26 (52.0)	4 (8.0)	15 (30.0)	
40-50	8 (16.0)	0 (0)	2 (4.0)	
Age /years				**0.001*[a]**
Med (Q1, Q3)	34 (28,37)	25 (23,26)	25 (22,31)	**0.001*[1,2]**
				0.001*[1,3]
Gender				
Male	9 (18.0)	35 (70.0)	17 (34.0)	**0.001*[b]**
Female	41 (82.0)	15 (30.0)	33 (66.0)	
Residence				
Urban	23 (46.0)	44 (88.0)	39 (78.0)	**0.001*[b]**
Rural	27 (54.0)	6 (12.0)	11 (22.0)	
Education				
Secondary school	6 (12.0)	9 (18.0)	4 (8.0)	0.065 [b]
Institute education	40 (80.0)	29 (58.0)	33 (66.0)	
Bachelor	4 (8.0)	12 (24.0)	13 (26.0)	
Marital status				
Single	8 (16.0)	26 (52.0)	25 (50.0)	
Married	39 (78.0)	19 (38.0)	25 (50.0)	**0.001***
Divorced/widow	3 (6.0)	5 (10.0)	0 (0)	
Body Mass Index				**0.001*[a]**
(BMI)	27.1	23.2	25.8 (22.9,	**0.001*[1,2]**
Med (Q1, Q3)	(24.0,30.5)	(22.6,26.8)	29.1)	**0.001*[2,3]**

Total vitamin D food intake per week (IU)	1701 (1203.1, 2246)	2093 (1582, 2690.5)	1540.5 (1362, 2081)	**0.001*[a] 0.001*[2,3] 0.003*[2,1]**

***** Statistically significant at 95% level of confidence a: Kruskal- Wallis test. b: chi- square test. Med (Q1, Q3): Median, first Quartile, third Quartile. 1,2 post hoc test between day shift staff and night shift staff. 2,3 post hoc test between night shift staff and rotating shift staff.

Table 1 showed that there is a statistically significant difference regarding age distribution between the studied groups (p <0.005) ,64% of the day shift staff age (30 to <40) years, where the night shift nursing staff are younger with median age 25 (23,26) years than day shift nursing staff 34 (28,37) years and rotating night shift 25 (22,31) years. Post hoc test showed that the difference is between day shift staff and night shift staff (p<0.005) and between day shift staff and rotating shift staff (p<0.005).

There is a statistically significant difference regarding nursing staff gender, most females were working in the day shift (82%) and rotating shift systems (66%), while males were predominantly working in night shifts (70%). Regarding residence, there is a statistically significant difference between groups, most of the day shift nursing staff (54%) living in rural areas, while most of those working at night and rotating shifts lives in urban.

There is a statistically significant difference between studied groups regarding Body Mass Index (BMI) (p< 0.005). The lowest for the night shift nursing staff 23.2 (22.6,26.8) and the highest for the day shift nursing staff 27.1 (24.0,30.5). The comparison between nursing staff regarding vitamin D food source intake per week showed that there is a statistically significant difference between the three studied groups as night shift staff group was significantly higher 2093 (1582, 2690.5) IU than the other day shift staff 1701 (1203.1, 2246) IU and the rotating shift staff 1540.5 (1362, 2081) IU.

Table 2. Comparison of Sun Exposure Index among the studied group (No =150):

Components	Day shift staff No. (%)	Night shift staff No. (%)	Rotating shift staff No. (%)	p-value
Walking in shadow				
Never	3 (6.0)	0 (0.0)	0 (0.0)	
Occasionally	22 (44.0)	10 (20.0)	18 (36.0)	**<0.001**[*c]
Often	16 (32.0)	31 (62.0)	24 (48.0)	
Always	9 (18.0)	9 (18.0)	8 (16.0)	
Face covering				
Never	18 (36.0)	18 (36.0)	15 (30.0)	
Occasionally	16 (32.0)	20 (40)	17 (34.0)	0.654[c]
Often	10 (20.0)	9 (18.0)	15 (30.0)	
Always	6 (12.0)	3 (6.0)	3 (6.0)	
Protective clothing				
Never	1 (2.0)	6 (12.0)	0 (0.0)	
Occasionally	10 (20.0)	15 (30.0)	10 (20.0)	**0.004**[*c]
Often	7 (14.0)	14 (28.0)	10 (20)	
Always	32 (64.0)	15 (30.0)	30 (60)	
Sun block use				
Never	45 (90.0)	35 (70.0)	26 (52.0)	
Occasionally	1 (2.0)	12 (24.0)	8 (16.0)	**<0.001**[*c]
Often	2 (4.0)	0 (0.0)	14 (28.0)	
Always	2 (4.0)	3 (6.0)	2 (4.0)	
Sun exposure index				
0	4 (8.0)	7 (14.0)	3 (6.0)	
1	26 (52.0)	14 (28.0)	16 (32.0)	
2	4 (8.0)	20 (40.0)	12 (24.0)	0.05[c]
3	14 (28.0)	6 (12.0)	10 (20.0)	
4	2 (4.0)	3 (6.0)	9 (18.0)	

*: Statistically significant at 95% level of confidence (p-value <0.05). [c]: fisher exact test.

Table 2 showed that there were significant statistical variations in Sun Exposure Index components among the tested groups, which included walking in the shadow ($p<0.005$), wearing clothes that covers all the body ($p<0.005$), and using sunblock ($p<0.005$).

In terms of total sun exposure index, there is no statistically significant difference between the groups in the examined sample.

Table 3. Comparison of serum level of vitamin D3 among the studied sample (No =150):

	Day shift staff [1] Med (Q1, Q3)	Night shift staff [2] Med (Q1, Q3)	Rotating shift staff [3] Med (Q1, Q3)	p-value
Serum vitamin D_3 level (ng/ml)	18 (15, 24)	13 (9, 17)	13.5 (11, 17)	**0.001*[a] 0.002* [1,2] 0.040*[1,3]**

* :Statistically significant at 95% level of confidence (P-value <0.05). a : Kruskal- Wallis test. Med (Q1, Q3): Median, first Quartile, third Quartile. 1,2 post hoc test between day shift staff and night shift staff. 1,3 post hoc test between day shift staff and rotating shift staff.

Table 3 showed that the highest serum vitamin D_3 was in the day shift staff which was 18 (15, 24) ng/ml and the lowest was in the night shift staff which was 13 (9, 17) ng/ml. Post–hoc test showed that the statistically significant difference is between day shift staff and night shift staff ($p<0.005$) and day shift staff and rotating shift staff ($p<0.005$).

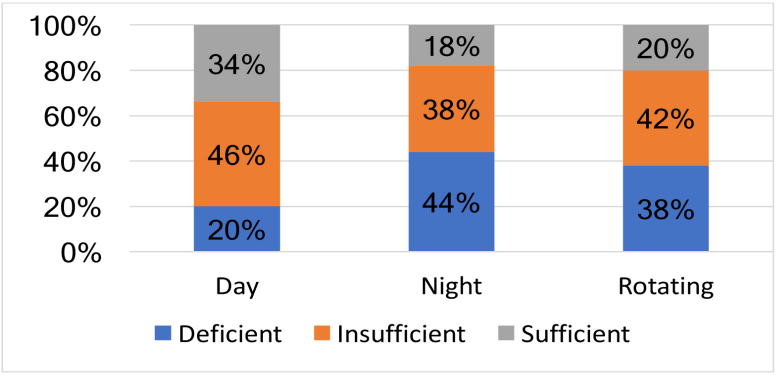

Figure (1). Comparison between vitamin D_3 status among the studied sample (No=150)

Figure 1 illustrated that vitamin D3 deficiency was higher among night shift staff (44%) and rotating shift staff (38%). Insufficient status was higher among the day shift staff (46%) and rotating shift staff (42%). Sufficient status was higher among the day shift staff (34%).

Table 4. Multiple logistic regression models for vitamin D3 deficiency.

	Odds Ratio (OR)	p-value	95%confidance interval for OR
Number of night shifts (per month)	1.933	**0.037***	0.971 – 2.427
Taking a nap	2.842	**0.030***	0.863- 3.199
Number of years working with night shift	1.334	**0.047***	0.017 - 4.018

* Statistically significant at 95% level of confidence

Excluded variables: - Age (years) – gender (1=male, 2= female) -Employment place (1= University hospital, 2=Ismailia complex) -Working duration /years, - Fatigue and tiredness (1=Yes ,0=NO), - current smoking (smoker =1, non-smoker=0).

Dependent variables (vitamin D_3 deficiency) : ≤12ng/ml= deficient =1 >12ng/ml=sufficient =0

Table 4 showed that the number of working night shifts per month, taking a nap while working within the night shift and number of years working with night shift are statistically significant predictors for vitamin D_3 deficiency ($p<0.05$).

Discussion

The prevalence of vitamin D_3 deficiency is widespread among workers across the world. This predominance might be attributed to a variety of causes, including population ageing, clothing (for cultural reasons), sunblock usage, a low-fat diet (fat enhance vitamin D absorption), and time spent indoors away from sun exposure during both work and daily activities (Rizza et al., 2020).

The present study aims at exploring the relation between night shift work and 25-hydroxy vitamin D_3 status; in addition to detect the occupational risk factors related to alteration of vitamin D_3 level among the hospital night shift nursing staff.

The current study showed a significant difference in median Body Mass Index (BMI) between the studied groups ($p<0.005$), with night shift nursing staff having the lowest median

BMI of 23.2 (22.6, 26.8) and rotating nursing staff having the highest median BMI of 25.8 (22.9, 29.1) kg/m2, with no association between vitamin D_3 level and BMI (Table1). This may be due to that most of the night shift staff are younger (90% less than 30 years old) with male predominance (70%) (Table1).

In comparison to Khamis et al.,2020 study findings which revealed that the BMI of the Alexandria nurses' group and Cairo nurses' group were within the overweight group. Between the two groups, there was a statistically significant inverse association between vitamin D level and Body Mass Index.

Another meta-analysis indicated that overweight and obese individuals in different age categories have a similar chance of presenting with vitamin D deficiency. So, the age does not seem to contribute significantly on this association (Pereira-Santos et al., 2015)

Furthermore, a Poland study about nurses detected a link between working at the night shift and gaining weight. Cross-sectional research of 724 female nurses and midwives aged 40-60 years (354 rotating night shift and 370 daytime employees) was done. As a result of the cumulative night shift labor, BMI increased by 0.477 kg/m2 each 1000-night responsibilities and by 0.432 kg/m2 per 10000-night shift hours. Obesity (BMI 30kg/m2) was linked with present and cumulative night work, with OR=3.9 (95% CI:1.5-9.9) in women reporting eight or more night shifts per month (Peplonska et al., 2019).

There was a significant statistical difference in total vitamin D intake from food sources per week between the three studied groups, with the night shift staff group was significantly higher (2093 (1582, 2690.5) IU versus the other day shift staff group (1701 (1203.1, 2246) IU and the rotating shift staff group 1540.5 (1362, 2081) IU (Table 1).

This was in disagreement with a study performed in Finland to explore food and nutrient intake differences between workers with different shift types and deduce that there was no significant difference regarding vitamin D food intake between day shift and other shift types (Hemiö et al., 2015).

In accordance with the current results, Varli and Bilici, 2016 who detected that in their research on "the nutritional condition of nurses working

shifts in Turkey" aged 25 to 50 and the education level was technical, while the mean working hours per day was 11.2±7.2 that affects their nutritional status which showed that they had higher fat intake compared to the control group .

There was a significant statistical difference in Sun Exposure Index(SEI) components across the studied groups. Such include walking in the shadow ($p<0.005$), wearing clothes that covers all the body ($p<0.005$), and using sunblock ($p<0.005$) . There is no significant statistical difference between the studied group and the overall sun exposure index values (Table 2).

This finding was made in the same line of the research work done by (Pilz et al., 2018)but vitamin D supplementation may also prevent extraskeletal diseases such as respiratory tract infections, asthma exacerbations, pregnancy complications and premature deaths. Vitamin D has a unique metabolism as it is mainly obtained through synthesis in the skin under the influence of sunlight (i.e., ultraviolet-B radiation on the generation of vitamin D_3 in the skin, which is controlled by a variety of factors such as skin pigmentation, cosmetics usage, sunblock application, outerwear, and the quantity of skin exposed.

On agreement with the current results ,Bachhel et al., 2015, detected that shift workers, regardless of geographical location, are more vulnerable to Vit D insufficiency than other jobs with constant daylight hours. On the contrary Jeong et al.,2014, revealed that a substantial number of employees in particular occupational categories are likely to be vitamin D deficient, even if they have access to sunshine at the ideal latitude .

Furthermore, a systematic review that evaluates the relationship between occupation and vitamin D_3 insufficiency showed that shift workers and indoor employees are regularly reported as the occupational category most likely to suffer from vitamin D_3 shortage. However, within this broad range, some occupational sectors have a greater incidence of deficiency than others, and this may be even higher in some employees than others within the same employment structure, despite the fact that all employees are prohibited from sunlight for the same amount of time. (Coppeta et al., 2018).

The systematic review also highlighted that the use of sunblock,

which has been aggressively encouraged, particularly in areas with high UVB exposure, as well as the sort of job being done, which may entail exposure to toxins, have the power to alter vitamin D3 levels (Coppeta et al., 2018).

Another Japanese study showed variations in serum vitamin D_3 level between indoor daytime employees and workers with other shift systems as the study found that establishing a definite relationship between vitamin D deficiency and indoor fixed-hour employees and shift workers is not always possible (Itoh et al., 2011).

There was a statistically significant difference in measured blood vitamin D_3 levels across the studied groups. The day shift staff median vitamin D_3 level was 18 ng/ml, whereas the night shift staff median vitamin D_3 level was 13 ng/ml. There is a significant statistical difference in blood vitamin D levels among the participating nursing staff ($p< 0.005$). There was a difference between day shift and night shift employees ($p< 0.005$), as well as day shift and rotating shift employees (Table 3), despite the night shift staff have more vitamin D food intake than the other groups (as mentioned in Table 1) and there is no statistically significant difference between groups regarding sun exposure index (mentioned in Table2), they have the lowest men serum vitamin D.

This is in agreement with a study done in Qatar and found that 96.5% of nursing staff had vitamin D levels below 30ng/ml. It is apparent that the prevalence of vitamin D deficiency within nurses is a worldwide phenomenon, regardless of where they work. The cause may be related to the extended time spent working inside and working at night (night shifts), which may prevent them from getting enough sunshine exposure (Mahdy et al., 2010).

The current results was in contrast to that of Lehnert et al., 2018, who found that shift employment had relatively minor impacts on vitamin D levels. The significant frequency of vitamin D deficiency is consistent with the findings from the German general population; this distinction is a result of geographic and cultural factors.

Alefishat and Abu Farha (2016) investigated the Vitamin D status of Jordanian personnel, including nursing staff, to establish the influence of the night shift effect and other risk factors, in order to examine the relationship between night shift and 25OHD

levels. A total of 140 Jordanian adults were recruited. The average 25OHD level was 23.8 ng/ml, according to the results. When compared to female day workers, female night workers exhibited substantially lower serum 25OHD levels (p 0.05). There was no significant difference in serum 25OHD levels between night and day male employees ($p > 0.05$).

Furthermore, Alavi and co-authors' study, 2016; detected that the mean 25 (OH) D level was 16.96 ng/mL (range: 3.5- 176.1 ng/mL) and 9.5% nurses had normal levels of vitamin D (30 to 100 ng/dL) in an Iranian study including 200 nurses.

The current study found that 44% of night shift nursing staff was deficient in vitamin D_3 and 38% were inadequate, whereas 46% of day shift nursing staff was deficient in vitamin D_3 and 34% were sufficient (Fig. 1).

An Egyptian research aimed to investigate the link between vitamin D deficiency and muscle and bone pain in nursing students at Cairo's Sayed Galal University Hospital. Three hundred female nurses were tested for 25-hydroxy vitamin D [25-OH] levels. The study revealed that vitamin D insufficiency was prevalent among working nurses (89%) and was seen as a major impediment to their employment (Elsheikh, 2018).The disparities between the latter and the current study could be attributed to variances in gender and age group, as the Elsheikh study only included female nurses.

Furthermore, the present study's findings agreed with those of another study done among 400 female nurses at Alexandria University Hospital and Al-Kasr AlAiny Obstetric Hospital, Cairo University. The study detected that 51.5% of nurses in Alexandria and 51.0% of nurses in Cairo had insufficient levels of 25-OHD, compared to 3.5% in Alexandria nurses and 13.5% in Cairo nurses who had severe deficiency (Khamis et al., 2020) .

Similar results were deduced by Alavi et al, 2016 that 45.5% of the nurses had severe insufficiency, 43.5% nurses had deficiency. The disparities between both studies were related to gender and age group differences, since the Iranian study included exclusively female nurses with mean ages older than the current studied group.

Divakar et al., (2020) investigated the association between vitamin D deficiency and its related job characteristics among indoor employees

in a multi-ethnic Southeast Asian country. The authors concluded that the participants' mean serum 25 (OH) D concentration was below the level considered ideal for general health, with one-third falling into the deficient category. Office employees and night shift workers were more likely to be vitamin D deficient.

Vitamin D_3 status was predicted using regression analysis among the studied group. It was found that the number of night shifts per month, as well as taking a nap during the night shift, were significant positive predictors of vitamin D insufficiency (Table4). This is consistent with the findings of an Iranian study that showed, the number of night shift/month was associated with lower vitamin D levels. They suggested that the workers with higher number of nights/month have lower duration of sun exposure (Alavi et al., 2016).Another study suggested that shift workers, health care employees and indoor workers are at a significant risk of developing vitamin D insufficiency, which may be due to major lifestyle factors such as lack of sunshine exposure (Sowah et al., 2017).

Study limitations: Several limitations should be noted. First, due to the cross-sectional design, causal relationship between statistically significant variables and vitamin D status cannot be ensured. Second, because this study only includes two public hospitals in Ismailia, which is a rather limited geographical region, caution is required when generalizing the study conclusions. Third, locating male nursing personnel who solely worked the day shift was difficult, and they were older than other groups. Fourth, nursing personnel working on the day shift had a history of working on the night shift, which did not define the accurate duration and other factors of work in connection to vitamin D levels. Fifth, some participants had difficulty recalling their dietary consumption of vitamin D2 resources. Finally, the Covid -19 epidemic restricted hospital access, making data collecting difficult, it was long and intermittent due to closure.

Conclusion: The present study demonstrated that among night shift nursing staff 44% had deficient vitamin D_3 and 38% were insufficient, while 46% of the day shift nursing staff had insufficient vitamin D_3 and 34% had sufficient levels. The individuals who work night and rotating night shifts showed lower levels of vitamin D_3 than

those with day shift only. Durations of night shifts, number of years working with night shifts and taking a nap were the predictors for vitamin D_3 deficiency.

Recommendations: Future studies with larger sample size are required to confirm the current study findings, and to explore other known confounders related to vitamin D status and dietary practices (e.g., vegan diet). Health education about sun exposure guidelines and vitamin D food sources is recommended for night and rotating shift nursing staff and indoor workers. Nursing staff should be encouraged to take breaks to go outdoors for sunlight exposure and to consume adequate amounts of vitamin D-rich foods; and vitamin D supplements to maintain optimal vitamin D levels. Screening for vitamin D levels among night shift nursing staff should be considered for future clinical practice guidelines and population health initiatives. Last, regular rescheduling of the shift-work between day shift and night shift-work on alternative basis should be considered.

Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship, and/ or publication of this article.

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