

Risk of breast cancer among female shift workers (systematic review)

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Abstract

Background: Shift work may increase the risk of breast cancer by decreasing melatonin production. This phenomenon by affecting pituitary gland and sexual hormonal secretion may increase the risk of breast cancer. The aim of this review study was to evaluate the results of studies for determining the relationship between shift work and breast cancer.

Methods: Data collection was done through worksheets appropriate to research objectives and searching among databases, including Medline, Google scholar and Scopus. Search keywords included shift work, night work and breast cancer. Studies were eligible for inclusion if they were observational, case-control or cohort studies that compared female shift workers with day workers. Animal studies, the studies that only examined mortality and benign breast disease, and works related breast cancer without focusing on shiftwork were excluded. Finally, a total of 16 studies consisted of 5 cohorts and 11 case controls were assessed.

Results: Among the prospective cohort studies, two studies reported an increased risk of breast cancer in association with shift work, but the rest did not find any relationship. Four of 11 case-control studies, indicated relation between shift work and breast cancer, but the remaining 7 studies did not report such finding. However 4 of 7 studies demonstrated that possibility of breast cancer will increase with increased number of night work per month and years of night work.

Conclusion: We concluded that shift work is a certain threat for females' health, and there may be the increased risk of breast cancer associated with long term night shift work.

Keywords: Females, Shift work, Night work, Breast cancer.

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The shift work that is considered as an unconventional paradigm and out of official hours (arbitrarily between 6 pm to 7 am), is a pattern which, although in the past centuries some working group such as bakers and lodging operators have practiced it (1, 2), but in recent decades, especially after the invention of the light bulb, has had a significant expansion as far as the proportion of shift workers in industrialized countries is allocated between 15 and 30 percent of the total workforce (3-6). It is expected that its real hit is even more in developing countries for reasons such as lack of proper discipline and working irregular hours (3,7).

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In addition to those, due to the need for technological limitations or economic pressures, have to work continuously day and night, many manufacturing and service sectors also rely on shift work. Shifts in the medical care field are naturally circadian, and doctors and nurses often are obliged to provide services based on a 24-hour system (8). Most of health care providers in all countries are female shift worker (rotating, evening and night) (9). Use of artificial light during night shifts is accompanied by disorders in the body's biological clock (circadian rhythm), and it is followed by disorders in the secretion of melatonin, and reduction of its production (10). This hormone is naturally made in the body by the pineal gland in the brain, which increases in the dark during the night and reversely reduces during daylight. The secretion of melatonin helps to regulate sleep-wake cycle (11-12). The role of this hormone, in addition to the above, is in some other physiological activities such as antioxidant effects and scavenging of free radicals, preventing premature death of cells, enhancing the immune system, and preventing premature aging and also plays an effective role in the treatment of depression, and dealing with HIV infection and suppressing the growth of cancer cells (13-14). Shift work is a kind of working pattern in a large group of people who have abnormalities in biological rhythms, sleep-wake cycle, and melatonin secretion; so, they are suffering from harmful effects, such as sleep disorders, fatigue, digestive disorders and heart disease (15-20). However, this working pattern is associated with a disruption in social activities and family life (11). Previous studies have shown that shift work and increased working hours have harmful effects on mental health, life satisfaction, a sense of happiness, a feeling of health and marital satisfaction (21-27). The pituitary gland is responsible for the production of sex hormones affects the circadian cycle, and naturally following the disturbance of the circadian cycle, causes irregularities in the production of sex hormones and the subsequent problems in the process of menstruation in women (28).

According to some researches, the night work (as a form of shift works) caused irregularities in hormone production, and this in turn leads to an increased risk of multifactorial cancers, especially hormone-dependent cancers such as breast cancer, endometrial and ovarian cancers (29-37). Such documentation has led the International Agency for Research on Cancer- IARC classified shift work as a probable human

cancer hazard in 2007 (38). Findings in human studies indicate an association between breast cancer risk and the level of melatonin metabolites in the urine (39-40). Based on these findings, the urinary metabolite of melatonin in night-shift nurses was significantly less than their day shift counterparts (41). Breast cancer is the most common cancer in women, and considered as a leading cause of cancer death in women, also that only 20-40% causes of breast cancer are known and many causes are still unknown (42-44), and the conflicting results about the relationship between shift work and breast cancer have published (31-35), this study aims to review the published reports in the context of shift work and breast cancer risk.

Methods

Data collection was done using work sheets appropriate for the purposes of scientific research and search was done through databases, including Medline, Google Scholar, and Scopus. To select the relevant articles, the keywords: shift work, night shifts and breast cancer were used. Quality assessment of studies (proper design, sample size, duration of follow-up, proper analysis and outcome) was performed by Critical Appraisal Skills Program (45), and middle and high quality studies were selected. Inclusion criteria for this review study were: a) comparison of samples among women working night shift and those who work day shift, also prospective cohort, case-control and retrospective studies, b) breast cancer pathology samples have been determined, c) Shifts in the studies should be defined at least based on one of the following concepts: the working shift system (shift rotation, fixed night shift, shift work with forward or backward turn), time shift during the year (starting and finishing time) and the shift work rate in a week or month.

Animal studies as well as the studies only looking at mortality and benign breast diseases, or the studies evaluating the relation of job without assessing shift work and night shift were excluded.

At first, 626 studies were found by searching shift work and breast cancer Key words, 192 of these studies were published; after examining the inclusion and exclusion criteria and quality assessment, at the end 16 studies were assessed (30-35, 46-55), 5 prospective cohort studies (31-32, 46-48), which had between 5 and 19 years of follow-up, and 11 case-control studies (30, 33-38, 49-55). Five studies were

about nurses and one study for telegraph and telephone operators; one study on female workers employed in textile factories, and one study on women in the military and 7 other studies on different jobs. Study participants were aged between 20 and 85 years (Tables 1 and 2). In most studies, the night shift was defined as jobs which had start and end times during the night. Data analysis tools for published articles were in a form of interviews, questionnaires or information recorded in the relevant centers. In all studies, samples are matched in terms of one or more variables with the risk factors for breast cancer such as age, age at menarche, age at birth of first child and using contraception drugs.

Results

From 5 prospective cohort studies, the two studies reported an increased risk of breast cancer due to shift work (32, 46). In two recent studies, one study was conducted in the USA and the subject was followed for 3 years on nursing women (32), and another study by Knutsson et al. was done in Sweden for 12 years on women with different jobs (46). Three other Cohort studies found no association between the two variables (31, 47-48). The study of Schernhammer et al.

on American work shift nurses in periodic follow-up for 11 years, the risk was reported only after 20 years of night shift (31). Study of Schwartzbaum et al. in a prospective cohort study with follow-up for 19 years on the Swedish working men and women found no increased risk of prostate and colon cancer in men and also in women with breast cancer (48). Another study was conducted in China, with 5-year follow-up that reported no relation between shift work and breast cancer (47).

From 11 case-control studies, researchers in 4 studies reported that shift work is associated with the increased risk of breast cancer in women (30, 33, 49, 53). The results of Menegaux et al. study from France on women with different jobs indicated that breast cancer risk in female shift worker is more than the control group (13% vs 11%), and the risk was higher in women who had their first child before they start work and work experience more than 4.5 years (53). In contrast, in the other 7 studies, night shift was not mentioned as a risk factor for breast cancer; of course, among the 7 most recent studies, the results of four studies have shown that with the increased number of night shifts per month, as well as increased year of night work for women, there would be an increase in the risk of breast cancer (34-35, 52-54). Characteristics of studies presented in Tables 1 and 2.

Table1: Characteristics of some studies regarding breast cancer risk among shift workers

Researcher	Study Time	Place of Study	Data Collection	Study Design	Mean Age of the Sample	Job
Davis, et al (30)	2001	USA	Interview	Case-Control	47	Different
Hansen (34)	2001	Denmark	File	Case-Control	42	Different
Hansen, et al (49)	2011	Denmark	Interview	Case-Control	70<	Nurse
Hansen, et al (50)	2012	Denmark	Questionnaire and Interview	Case-Control	70<	Military women
Knutsson (46)	2012	Sweden	Questionnaire	Prospective Cohort	41	Different
Li, et al (51)	2011	China	Interview	Case-Control	48	Nurse
Lie, et al (35)	2006	Norway	Interview	Case-Control	56	Nurse
Lie, et al (52)	2011	Norway	Interview	Case-Control	54	Textile workers
Menegaux, et al (53)	2011	France	Interview	Case-Control	49	Different
O'Leary, et al (54)	2006	German	Interview	Case-Control	55	Different
Pesch, et al (55)	2010	USA	Interview	Case-Control	56	Different
Pronk, et al (47)	2010	China	Interview	Prospective Cohort	52	Different
Schernhammer, et al(32)	2001	USA	Questionnaire	Prospective Cohort	55	Nurse
Schernhammer, et al(31)	2006	USA	Questionnaire	Prospective Cohort	40	Nurse
Schwartzbaum, et al (48)	2007	Sweden	File	Prospective Cohort	57	Different
Tynes, et al (33)	1996	Norway	File	Case-Control	52	Telegraph and radio operators

Table 2: Statistical parameters in some studies regarding breast cancer risk among shift workers

Researcher	Analysis Results		The Number of Samples	
Davis, et al (30)	OR: 1.14	CI (1.01, 1.13)	Case: 768	Control: 741
Hansen (34)	OR: 1.5	CI (1.2, 1.7)	Case: 6281	Control: 6024
Hansen, et al (49)	OR: 2.9	CI (1.1, 8.0)	Case: 267	Control: 1035
Hansen, et al (50)	OR: 2.3	CI (1.1, 8.0)	Case:132	Control: 505
Knutsson, et al (46)	RR: 1.23	CI (0.7,2.17)	Expose: 549	Non Exposed: 2511
Li, et al (51)	RR: 1.03	CI (0.84,1.21)	Case: 1709	Control: 4780
Lie, et al (35)	OR: 2.21	CI (1.10, 4.5)	Case: 537	Control: 2143
Lie, et al (52)	OR: 1.20	CI (0.8, 1.6)	Case: 699	Control: 895
Menegaux, et al (53)	OR: 1.27	CI (0.99-1.64)	Case:1232	Control: 1317
O'Leary, et al (54)	OR: 1.65	CI (1.02, 2.69)	Case: 487	Control: 509
Pesch, et al (55)	OR: 1.83	CI (1.15, 2.93)	Case: 746	Control: 793
Pronk, et al (47)	OR: 1.73	CI (0.71, 4.22)	Exposed: 18234	Non Exposed: 51236
Schernhammer, et al (32)	RR: 0.9	CI (0.7, 1.1)	Exposed: 46801	Non Exposed: 31761
Schernhammer, et al (31)	RR: 1.79	CI (1.06, 3.01)	Exposed: 78063	Non Exposed: 35153
Schwartzbaum, et al (48)	SIR: 0.94	CI (0.74-1.18)	Exposed: 70	Non Exposed: 274
Tynes, et al (33)	OR: 1.5	CI (1.1, 2.5)	Case: 50	Control: 259

Discussion

This review aimed to examine the association between shift work and breast cancer in women. Six of the 16 studies showed that with increased duration of shift work, especially after 20 years, or increased number of shifts per week or month, the risk of breast cancer increases in women (31, 34, 35, 46, 52, 54). In 5 studies conducted on nurses to assess breast cancer risk, 2 studies reported the increased risk of cancer with shift work (32, 49), and in 3 other studies, the increased risk was reported if the duration or length of work year increase (especially more than 5 years) (31, 35, 52). It seems that the long-term shift and reduced melatonin secretion have an important role in the incidence of this complication. Obviously, the more accurate judgment on this issue requires laboratory research and urinary melatonin metabolite changes review during the first year of employment as shift work up to the end. It is only then that it can be more carefully judged about the relationship between shift work and increased risk of breast cancer in shift workers.

According to current knowledge, the mechanisms involved in the apparent protective tumorigenesis of melatonin is attributed to roles such as a direct anti-proliferative effect, strengthening the immune system, preventing the creation of free radicals in the body and also the expression of P53 gene as breast tumor suppressor.

Complete inhibition or reduction of melatonin secretion in the body depends on factors such as long-term exposure to artificial light during the night shift, also its intensity and wavelength. Onset or growth of cancer cells in the body is associated with reduced levels of melatonin (50). Multiple and often consecutive shift work can disrupt the circadian rhythm and some associated biological functions such as sleep problems, while small number of shift work about one or two nights per week probably is not associated with the disorder and severe problem in circadian rhythm (52).

Therefore, it is recommended to adopt measures such as:

- Assign a smaller number of night shifts per week or month or in fewer years of working life,
- Run the shift program to rotate forward (morning, afternoon, evening),
- Choose shift work persons on a voluntary basis,
- Offer special pattern of shift work with fewer long hours at night (for example, 8 hours in the morning, 9 hours in the evening and 7 hours evening and night-time),
- Breast cancer screening for night shift workers with a history of more than 5 years

According to the findings, the risk of breast cancer in morning preference is more than an evening preference (50). Morning preference is a major inhibitor in harmony and consistent with the work shift and these individuals have more severe circadian rhythm disorder. Therefore, to reduce

the effects of shift work, it is essential to consider this characteristic of the individual.

The distinctive feature of this review article is to summarize researches on breast cancer in women who work day shift compared to those who work night shift. But in the last review studies, comparing cancer among shift work women with other women was done in a way that even non-working women were also entered and evaluated because of the inclusion criteria (30, 42). So it seems that the results may have less bias, and also better and more precise estimate of the risk of breast cancer in shift works is provided.

Breast cancer, with an incidence of about 22% is known as the most common cause of cancer deaths in Iranian women and compared to the developed countries, the average age of women suffering from this condition is a decade less than their counterparts (56). The online search on multiple scientific studies have shown that there is no research trying to study the relationship between shift work and breast cancer. Thus, since Iran is a developing country, and for reasons such as lack of proper organization and irregular work hours, there are higher hours of shift work in some businesses (3, 7) and also in some jobs, especially in health care services, due to lack of workforce, they face with the problem of overtime in shift workers (57), So more studies should perform in this regard.

In the end, the prospective cohort studies extensively in different regions and in different professions, especially medical staff that the vast majority of it is women are needed to obtain more precise results in order to judge more certain about the adverse consequences of shift work and apply preventive measures.

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References

- Zamanian Z, Dehghani M, Mohammady H, Rezaeiani M, Daneshmandi H. Investigation of shift work disorders among security personnel. *Int J Occup Hyg* 2012;4(2): 91-4.
- Harrington J. Health effects of shift work and extended hours of work. *Occup Environ Med* 2001;58(1):68-72.
- Boivin DB, Tremblay GM, James FO. Working on atypical schedules. *Sleep Med* 2007;8(6):578-89.
- Tirgar A. Problems due to shift work in nurses of some cities in Mazandaran Province. *Proceeding of the First International Conference on Ergonomics*. Iran: Tehran; May 7-8 2008; pp: 388-92. Available at: http://www.civilca.com/paper-IRANERGO01-IRANERGO1_054.html
- American Academy of Sleep Medicine. *The international classification of sleep disorders: diagnostic and coding manual*. Washington, DC: American Academy of Sleep Medicine 2005.
- Nezamodini ZS, Shahhoseyni P, Behzadi E, Latifi SM. Relationship between shift works with sleep disorders and public health in a pipe Co. *J Saf Promot Inj Prev* 2014;2(3):189-95. [in Persian]
- Bohle P, Quinlan M, Kennedy D, Williamson A. Working hours, work-life conflict and health in precarious and "permanent" employment. *Rev Saude Publica* 2004;38(Suppl):19-25.
- Korompeli A, Muurlink O, Tzavara CH, Velonakis E, Lemonidou CH, Sourtzi P. Influence of Shiftwork on Greek Nursing Personnel. *Saf Health Work* 2014;5(2):73-9.
- Demers PA, Wong I, McLeod C. The prevalence of shift work in Canada " scientific symposium: the health effect of shift work, Tronto, April 12, 2010.
- Shokrzadeh M, Nasri Nasr Abadi N, Abedian S, Ataee R, Hosseini S, Ansari Z. Role of melatonin receptor in patients with gastric adenocarcinoma in Mazandaran province. *J Mazandaran Univ Med Sci* 2014;23(109):9-15. [in Persian]
- Spengos K, Tsivgoulis G, Manios E, Tsivgoulis A, Zakopoulos N, Vemmos KN. Circadian and seasonal distribution of cardioembolic strokes due to atrial fibrillation. *Hellenic J Cardiol* 2004; 45: 234-41.
- Sadeghniaat-Haghighi K, Aminian O, Pouryaghoub GH, Yazdi Z. Efficacy and hypnotic effects of melatonin in shift-work nurses: double-blind, placebo-controlled crossover trial. *J Circadian Rhythms* 2008; 6: 10.
- Pandi-Perumal SR, Sirinivasan V, Maestroni GJ, et al. Melatonin: nature's most versatile biological signal? *FEBS J* 2006;273(13):2813-38.

14. Rodriguez C, Mayo JC, Sainiz RM, et al. Regulation of antioxidant enzyme: a significant role of melatonin. *J Pineal Res* 2004;36(1):1-9.
15. Ijaz S, Verbeek J, Seidler A, et al. Night-shift work and breast cancer—a systematic review and meta-analysis. *Scand J Work Environ Health* 2013; 39(5):431-47.
16. Erren TC, Pape HG, Reiter RJ, Piekarski C. Chronodisruption and cancer. *Naturwissenschaften* 2008;95(5):367-82.
17. Lehtimäki A, Helander ML, Pessi AM. Circadian periodicity of airborne pollen and spores; significance of sampling height. *Aerobiologia* 1991;7(2):129-35.
18. Wang XS, Armstrong MEG, Cairns BJ, Kay TJ, Travis RC. Shift work and chronic disease: the epidemiological evidence. *Occup Med* 2011;61(2):78-89.
19. Demerouti E, Bakker AB, Bulters AJ. The loss spiral of work pressure, work-home interference and exhaustion: reciprocal relations in a three-wave study. *J Vocat Behav* 2004;64 (1):131-49.
20. Janssen D, Nachreiner F. Health and psychosocial effects of flexible working hours. *Rev Saude Publica* 2004;38(Suppl):11-8.
21. Costa G. Shift work and occupational medicine: an overview. *Occup Med (Lond)* 2003;53(2):83-8.
22. Choobineh A, Soltanzadeh A, Tabatabaee SHR, Jahangiri M, Khavvaji S. Shift work-related health problems in "12-hour shift" schedule in petrochemical industries. *Iran Occupational Health J* 2010;7(1):44-53. Available at: http://ioh.iums.ac.ir/browse.php?a_code=A-10-1-18&slc_lang=en&sid=1 [in Persian]
23. Wilson J. The impact of shift patterns on healthcare professionals. *J Nurs Manag* 2002;10(4):211-9.
24. Soleimany MA, Nasiri-Ziba F, Kermani A, Hoseini F. A comparative study of the general health among staff nurses with fixed or rotating working shift. *Iran J Nurs* 2007;20(50):21-8.
25. Bamba CL, Whitehead M, Sowden A, Akers J, Petticrew M. Shifting schedules: the health effects of reorganizing shift work. *Am J Prev Med* 2008; 34(5):427-34.
26. Knutsson A. Health disorders of shift workers. *Occup Med Lond* 2003;53(2):103-8.
27. Presser HB. Nonstandard work schedules and marital instability. *J Marriage Fam* 2008;62(1):93-110.
28. Linden J. Influence of shift work on early reproductive outcomes: a systematic review and meta-analysis. *Obstet Gynecol* 2014;124(1):99- 102.
29. Megdal SP, Kroenke CH, Laden F, Pukkala E, Schernhammer ES. Night work and breast cancer risk: a systematic review and meta-analysis. *Eur J Cancer* 2005;41(13):2023-32.
30. Davis S, Mirick DK, Stevens RG. Night shift work, light at night, and risk of breast cancer. *J Natl Cancer Inst* 2001;93(20):1557-62.
31. Schernhammer ES, Kroenke CH, Laden F, Hankinson SE. Night work and risk of breast cancer. *Epidemiology* 2006;17(1):108-11.
32. Schernhammer ES, Laden F, Speizer FE, et al. Rotating night shifts and risk of breast cancer in women participating in the nurses' health study. *J Natl Cancer Inst* 2001;93(20):1563-8.
33. Tynes T, Hannevik M, Andersen A, Vistnes AI, Haldorsen T. Incidence of breast cancer in Norwegian female radio and telegraph operators. *Cancer Causes Control* 1996;7(2):197-204. [PubMed].
34. Hansen J. Increased breast cancer risk among women who work predominantly at night. *Epidemiology* 2001;12(1):74-7.
35. Lie JA, Roessink J, Kjaerheim K. Breast cancer and night work among Norwegian nurses. *Cancer Causes Control* 2006;17(1):39-44.
36. Viswanathan AN, Hankinson SE, Schernhammer ES. Night shift work and the risk of endometrial cancer. *Cancer Res* 2007;67(21):10618-22.
37. Bhatti P, Cushing-Haugen KL, Wicklund KG, Doherty JA, Rossing MA. Nightshift work and risk of ovarian cancer. *Occup Environ Med* 2013;70(4):231-7.
38. International Agency for Research on Cancer. IARC monographs on the evaluation of carcinogenic risks to humans. Painting, firefighting, and shiftwork. Lyon: International Agency for Research on Cancer 2010; pp: 563-766. Available at: <http://www.iarc.fr/en/publications/list/monographs/>
39. Schernhammer ES, Hankinson SE. Urinary melatonin levels and breast cancer risk. *J Natl Cancer Inst* 2005;97(14):1084-7.
40. Schernhammer ES, Berrino F, Krogh V, et al. Urinary 6-sulfatoxymelatonin levels and risk of breast cancer in

- postmenopausal women. *J Natl Cancer Inst* 2008;100(12):898-905.
41. Kakooei H, Zamanian Ardakani Z, Karimian S, Ayattollahi S. Twenty four- hour circadian melatonin profile among women shift work nurses. *Zanjan Univ Med Sci J* 2009;17(68):75-84. [in Persian]
 42. Tavakolijan L, Bonyadi F, Malekzadeh E. The investigation of factors associated with breast cancer screening among Kazeroon women aged 20-65 in 2013. *NVJ* 2015;1(1): 7-31. Available at: http://njv.bpums.ac.ir/browse.php?a_code=A-10-277-4&sid=1&slc_lang=en [in Persian]
 43. Kamdar BB, Tergas AI, Mateen FJ, Bhayani NH, Oh J. Night-shift work and risk of breast cancer: a systematic review and meta-analysis. *Breast Cancer Research and Treatment* 2013;138(1):291-301.
 44. Coyle YM. The effect of environment on breast cancer risk. *Breast Cancer Res Treat* 2004;84(3): 273-88.
 45. Critical Appraisal Skills Programme (CASP). CASP Checklists 2013. Available at: <http://www.casp-uk.net/#!/casp-tools-checklists/c18f8> .
 46. Knutsson A, Alfredsson L, Karlsson B, et al. Breast cancer among shift workers: results of the WOLF longitudinal cohort study. *Scand J Work Environ Health* 2013;39(2):170-7.
 47. Pronk A, Ji BT, Shu XO, et al. Night-shift work and breast cancer risk in a cohort of Chinese women. *Am J Epidemiol* 2010;171:953-9.
 48. Schwartzbaum J, Ahlbom A, Feychting M. Cohort study of cancer risk among male and female shift workers. *Scand J Work Environ Health* 2007;33(5):336-43.
 49. Hansen J, Stevens RG. Case-control study of shift-work and breast cancer risk in Danish nurses: impact of shift systems. *Eur J Cancer* 2011;48(11):1722-9.
 50. Hansen J, Lassen CF. Nested case-control study of night shift work and breast cancer risk among women in the Danish military. *Occup Environ Med* 2012;69(8):551-6.
 51. Li W, Ray RM, Thomas DB, et al. Occupational exposure to magnetic fields and breast cancer among women textile workers in Shanghai, China. *Am J Epidemiol* 2013;178(7):1038-45.
 52. Lie JA, Kjuus H, Zienolddiny S, Haugen A, Stevens R G, Kjarheim K. Night work and breast cancer risk among Norwegian nurses: assessment by different exposure metrics. *Am J Epidemiol* 2011;173(11):1272-9.
 53. Menegaux F, Truong T, Anger A, et al. Night work and breast cancer: a population-based case-control study in France (the CECILE study). *Int J Cancer* 2013;132(4):924-31.
 54. O'Leary ES, Schoenfeld ER, Stevens RG, et al. Shift work, light at night, and breast cancer on Long Island, New York. *Am J Epidemiol* 2006;164(4):358-66.
 55. Pesch B, Harth V, Rabstein S, et al. Night work and breast cancer- results from the German GENICA study. *Scand J Work Environ Health* 2010;36(2):134-41.
 56. Harirchi I, Karbakhsh M, Kashefi A, Momtahn AJ. Breast cancer in Iran: results of a multi-center study. *Asian Pac J Cancer Prev* 2004;5(1):24-7.
 57. Tirgar A. Effects of mandatory extra work among shift workers, 1st Biennial Iranian Conference on Ergonomics, 15-16 October 2014, Hamedan, Iran. [in Persian]