



Research Paper

Relationship Between Shift Work and Cardiovascular disease Risk Factors in Workers Referred to Occupational Medicine Center of Gonabad University of Medical Sciences



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ABSTRACT

Background: There are many well-known biologic and anthropometric risk factor for Developing Cardiovascular Diseases (CVD). Shift Work (SW) may be associated with CVD risk factors.

Objectives: This study was performed to investigate the relationship of shift work and some of CVD risk factors.

Materials & Methods: This analytical cross-sectional study was done in Occupational Medicine Center of Gonabad University of Medical Sciences from April to December in 2021. A total of 743 workers who referred for periodic health examination were selected by simple random sampling. Those workers with at least one year of work experience who had Satisfaction for participation were included to the study. Having congenital heart disease, heart failure, kidney disease, Taking drugs that increase blood pressure, blood lipid and sugar and pregnant women were excluded. Demographic data, Physical examination and Blood cholesterol, triglyceride and glucose measures were collected. Data analysis was performed using Mann-Whitney U test, student t-test, Chi-Square and Multivariate Linear Regression model with SPSS software version 21 at a significant level of 0.05.

Results: Of total, 73.4% were men and 47.3% were shift workers. The Mean±Standard Deviation of age was 33.9±5.07 among shift workers, and 36.32±5.81 among Day-time workers. There was significant independent association between shift work and triglyceride (B=7.5, 95%CI=1.02,1.21, P=0.03) and cholesterol (B=7.2, 95%CI=1.12,1.22, P=0.028) values.

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Conclusion: The results of the present study showed that the concentration of blood triglycerides and cholesterol is higher in shift workers than day-time workers. Therefore, particular follow-up of shift workers should be recommended for screening and preventing cardiovascular risk factors

Keywords: Cardiovascular, Risk Factor, Shift Work

1. Introduction

Shift workers have an important role in the 24-hour work of many industries, hospitals, and health care centers. Approximately, 18% of all European workers work in shifts, and this rate is as high as 35% in some countries [1]. This type of work schedule alters circadian rhythms of the workers which may adversely affect glucose and lipid metabolism, inflammatory process, and nervous system, and also increase the risk of atherosclerosis, dyslipidemia, and insulin resistance [2, 3]. In recent years, numerous studies [4-9] have been done about the relationship between cardiometabolic diseases such as cardiovascular disease, type 2 diabetes [4, 5] and obesity [6, 7] with shift work. For example, two meta-analysis studies showed that there is a significant relationship between shift work and weight gain [6, 7]. Other systematic and meta-analytic studies also showed that shift work is related with metabolic syndrome [8], cardiovascular disease [5, 9], and type 2 diabetes [4]. However, there are conflicting results in some studies [10-12]. For example, Dong et al. (2022) in a study on shift work and metabolic syndrome revealed that long-term shift work is not associated with a significantly increased risk of metabolic syndrome and Long-term shift work is only associated with elevated systolic blood pressure and waist circumference [12]. Shift work status may play an important role in hypertension (HTN), as there is a significant relationship between rotating shift work and HTN. However, there is no significant relationship between night shift status and the risk of HTN [11]. Cardiovascular disease and type 2 diabetes are common diseases which may cause death and severe complications. Understanding the effect of shift work on the cardiovascular diseases risk factors help us control these diseases. Although the results of various studies have shown that shift work contributes to the development of the cardiovascular disease [2-5]. There are few studies on the effect of shift work on the risk factors which cause this relationship [10, 11]. In addition, it is important to understand the impact of shift work on metabolic risk factors such as body mass index and cholesterol, triglycerides [13], blood sugar and blood pressure [14] in terms of secondary prevention [6, 7, 15]. This study was aimed to investigate the Relationship between Shift Work and Cardiovascular disease

Risk Factors in workers who referred to Occupational Medicine Center of Gonabad University of Medical Sciences for periodic health examination from April to December in 2021.

2. Methods

Study type and study population

This analytical cross-sectional study was conducted in workers Referred to Occupational Medicine Center of Gonabad University of Medical Sciences from April to December in 2021. Those workers with at least one year of work experience and who gave consent to participate in the study were included. Subjects with congenital heart disease, heart failure, kidney disease, Taking drugs that increase blood pressure, blood lipid and sugar and pregnant women were excluded. The shift and non-shift work group were selected from individuals who had referred to the university's Occupational Medicine Center for periodic health examinations. From 1845 Potential candidate, 743 eligible sample were selected and categorized into day and night shift-workers.

Study variables

Demographic data such as age, gender, shift work, smoking habits, as well as the history of any cardiovascular disease were extracted through a researcher-made demographic checklist. Daytime or non-shift work was defined as work time from 7:00 AM to 3:00 PM. Shift-work was defined as working time outside 7:00 AM to 3:00 PM among which work time from 7:00 PM to 7:00 AM was considered as fixed night work. People who smoked one or more cigarettes a day for one year were considered smokers. Blood pressure was measured with a Richter calibrated mercury barometer. The participant was first asked about the intense physical activity and consumption of tea, coffee and cigarettes half hour before the visit. In case of a negative answer, the person rested for 5 minutes then his blood pressure was measured in a calm environment. The person's height was measured using tape centimeter (ADE10038). Weight was measured by light clothing using digital calibrated scale (ASmed). Fasting Blood Sugar (FBS), Total Cholesterol (TCHOL), and Triglycerides (TG) were mea-

sured at the hospital's laboratory while fasting for 12-14 hours. Hypertension was defined as Systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg. Hypercholesterolemia and hypertriglyceridemia were defined as TCHOL ≥ 200 mg/dl, and TG ≥ 150 mg/dl. Diabetes was defined as FBS ≥ 126 mg/dl and body mass index was more than 25, which were considered abnormal [16-18].

Statistical analysis

The normality of continuous variables was assessed by Kolmogorov-Smirnov test. Data description was reported by mean and Standard Deviation (SD) for continuous and frequency and percentage for categorical variables. The association between variables were analyzed using Student's t-test, Chi-Square, and Mann-Whitney U test. Multivariate Linear Regression model was used to estimate the independent of shift work and cardiovascular risk factors adjusted for demographic variables. All statistical analysis was performed by SPSS version 21 at a significant level of 0.05.

3. Results

Of 743 participants, 73.4% (546 individuals) were male. Overall, 47.3% (352 individuals) were shift work-

ers among them 10 individuals were fixed night workers and remaining were rotating shift workers. Ninety six percent (337 individuals) of the shift workers were male. Table 1 shows demographic information in the two groups of shift and daytime workers. The mean age of the shift workers (33.9, SD=5.07) was significantly lower than daytime workers (36.32, SD=5.81). The work experience of 74.8% (555 individuals) was less than ten years and the mean of work experience in shift workers was significantly lower than daytime workers (P=0.001). There was a significant relationship between smoking and shift work (P=0.014) with higher prevalence of smoking among shift workers (5.6 %) than daytime workers (2.3 %).

Table 2 shows distribution of cardiovascular risk factor in the two groups. The mean values of TCHOL and TG in shift workers was significantly higher than daytime workers (P<0.001).

The results of multivariate linear regression for the association of shift worker and cardiovascular risk factors adjusted for demographic variables are shown in Table 3. All cardiovascular risk factors were related to the age and work experience of the participants. Each year increase in age and work experience was associated with higher level of SBP, DBP, BMI, TG, TCHOL, and FBS.

Table 1. Demographic characteristics of study participants according to the daytime and shift work

Variable	Daytime Workers (N=391)	Shift Workers (N=352)	P
Gender	Male	209	0.096
	Female	182	
Smoking	9	20	0.014
Years	36.3 \pm 5.08	33 \pm 5.07	0.001
Work experience (years)	8.3 \pm 2.6	5.4 \pm 2.7	0.001



Table 2. Cardiovascular risk factors according to the daytime and shift work

Variable	Mean \pm SD		P
	Daytime Worker	Shift Worker	
Systolic blood pressure	112 \pm 11.37	114 \pm 5.07	0.44
Diastolic blood pressure	69.5 \pm 6.9	70.75 \pm 5.8	0.285
Fasting blood sugar	80.56 \pm 15.8	80.46 \pm 12.03	0.32
Blood triglycerides	111 \pm 74	216 \pm 78.6	0.022
Blood cholesterol	158 \pm 30.8	163 \pm 31	0.029
Body mass index	24.7 \pm 4.47	24.0 \pm 4.08	0.07



Table 3. Multiple linear regression model between shift work and cardiovascular disease risk factors

Variable	B(95%CI) P					
	DBP	SBP	BMI	TG	TCHOL	FBS
Gender (male)	1.9 (0.7,3) 0.001	3.8 (2,5.5) 0.001	-1.2(-1.9,-0.6) 0.022	7.5 (0.9,1.4) 0.024	3 (0.4, 1.18) 0.044	-1.7 (-4,1.1) 0.2
Age (year)	0.18(0.16,0.2) 0.001	0.3(0.2,0.4) 0.001	0.02(0.3,0.15) 0.001	0.3 (0.8,2) 0.001	0.8 (0.5,1.7) 0.001	0.2 (0.06,0.4) 0.008
Work experience (year)	2.3 (1.8,2.8) 0.001	4 (3.4,4.8) 0.001	3 (2.8,3.3) 0.001	0.02 (1.3,1.9) 0.001	0.02 (0.2,2.1) 0.03	1.8 (0.7,2) 0.001
Smoke (smoke)	- 1.9 (-4,0.2) 0.08	0.28 (-3,3.6) 0.86	-0.7 (-1.9,0.4) 0.2	0.9 (-0.21,2.3) 0.9	2 (-1.8,3.4) 0.72	1.3 (-3,6.6) 0.6
Shift work (shift)	0.9 (-0.09,1.9) 0.07	1.2 (0.3,0.6) 0.11	-0.3 (-0.2,0.8) 0.28	7.5 (1.02,1.21) 0.03	7.2 (1.12, 1.21) 0.028	1.5 (-0.9,4) 0.2



FBS: Fasting Blood Glucose; Chol: Blood cholesterol level; TG: Blood triglyceride level; BMI: Body Mass Index; SBP: Systolic blood pressure; DBP: Diastolic blood pressure. B: Regression coefficient.

Male workers had higher values of SBP, DBP, TG, and TCHOL compared to female workers. Shift work was independently associated with higher level of TCHOL (B=7.5, 95% Confidence Interval (CI):1.02,1.21) and TG values (B=7.2, 95%CI: 1.12, 1.21).

4. Discussion

The results of the present study showed that there was a higher concentration of blood triglyceride and cholesterol among shift workers compared to daytime workers. Other cardiovascular risk factors, such as abnormal fasting blood sugar, body mass index, and increased systolic and diastolic blood pressure, were not significantly related with shift work.

Some studies have shown that there is no significant difference between blood triglyceride concentration in shift workers and daytime workers [19], while several other studies have shown that shift work can lead to increased triglyceride concentrations [10, 20, 21]. Studies show that the effect of shift work on increasing triglyceride concentrations is independent of the dietary effect [22]. Several researches have shown that there is a significant relationship between shift work and rising cholesterol concentrations [10]. One study found that the blood cholesterol of shift workers were four times more than that of the daytime workers [23]. There are some explanations that may justify these findings; first; Irregular food intake may influence energy balance and weight regulation, which lead to metabolic disturbance. Second, circadian disruption and eating meals irregularly disturb

the natural rhythmicity of insulin action and lead to insulin resistance and obesity [12].

However, one study has shown that the relationship between shift work and hypercholesterolemia (Chol>= 200), may happen after twenty years of shift work [24]. Our study population was young with little work experience and few years of shift work; therefore, there might be stronger association after several years of permanent work.

The main behavioral contributors of cardiovascular risk factors such as diet, physical activity and sleep quality did not assess in current study. They may play an important role in shift work and metabolic risk factors. The effect and role of these lifestyle habits should be determined in the relationship between shift work and metabolic risk factors. These limitations have also been found in other studies [25-28].

According to the results of the present study, although the mean systolic and diastolic blood pressure in shift workers was higher than non-shift workers but this difference was not significant. The results of the present study showed that the number of people with high blood pressure in shift workers was higher than daytime workers, but the difference was not significant because older age workers with hypertension were not involved in shift work after diagnosis. In a study conducted on shift workers in China, a correlation was found between increased blood pressure and shift work [29]. A cohort study conducted in Japan also showed that shift work affects both systolic and diastolic blood pressure. This effect was also

greater than the effect of age and body mass index [30]. Additionally, a study conducted in Korea revealed that there was no significant relationship between shift work and high blood pressure [31]. However, regarding the fact that workers were grouped based on work experience, it was observed that the prevalence rate of hypertension increased with the higher work experience and the larger amount of time spent. Studies show that cardiovascular disease begins 5 years after shift work [32]. Non-shift workers may be an unhealthy group or a group who have changed their job due to illness. Therefore, it can be a sign of being healthy. Usually, healthy people are employed in shift work.

The results of the present study showed that smoking is more common among shift workers than daytime workers. Moreover, based on the results of this study, there was no correlation between fasting blood sugar and body mass index with shift work. A cohort study on nurses showed that shift workers had a higher body mass index and higher diabetes rates, compared with daytime workers [33]. In a meta-analysis study conducted in 2017, similar results were obtained [34]. However, other studies did not confirm this relationship [24]. Recent meta-analyses and systematic reviews have attempted to combine the various epidemiological studies providing evidence for a relationship between shift work and metabolic syndrome, diabetes mellitus, obesity, hypertension and cardiovascular disease [35].

This study had the advantages of using multiple laboratory factors and relatively high sample size compared to the similar studies. But it suffers from several limitations: Due to the low number of fixed night shift workers, mostly rotational shift workers and daytime workers were studied in the present study. Accordingly, it is suggested that in future research, the variables in this study be checked on fixed night shift workers. In addition, it is possible to relocate or allow for early retirement of the shift workers with cardiovascular disease, and this may cause the prevalence of cardiovascular risk factors among shift workers to be less than the actual rate. Therefore, it is suggested that these limitations be considered in future studies. Due to the large number of risk factors for cardiovascular disease, such as stress and job security, dietary patterns, work schedule details, such as the number of days off per month, long working hours and income, were not studied in this study. It is suggested that these risk factors be considered and according to the type of study, which is cross-sectional, a cohort study be done with larger sample size in the future.

5. Conclusion

The results of the present study showed that the blood triglycerides and cholesterol concentration, are higher in shift workers than daytime workers. Therefore, our data showed that shift workers are at higher risk of cardiovascular disease and cardiovascular risk factor screening programs should become compulsory for shift workers.

Ethical Considerations

Compliance with ethical guidelines

The study protocol was approved by the Ethics Committee of Gonabad University of Medical Sciences, Iran (Code: IR.GMU.REC.1398.114).

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Authors' contributions

All authors equally contributed to preparing this article

Conflict of interest

The authors declared no conflict of interest.

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References

- [1] Boivin DB, Boudreau P. Impacts of shift work on sleep and circadian rhythms. *Pathol Biol.* 2014; 62(5):292-301. <https://www.sciencedirect.com/science/article/abs/pii/S0369811414001230>
- [2] Sooriyaarachchi P, Jayawardena R, Pavey T, King NA. Shift work and the risk for metabolic syndrome among healthcare workers: A systematic review and meta-analysis. *Obes Rev.* 2022:e13489. [DOI:10.1111/obr.13489] [PMID]
- [3] Puttonen S, Härmä M, Hublin C. Shift work and cardiovascular disease-pathways from circadian stress to morbidity. *Scand J Work Environ Health.* 2010;96-108. [DOI:10.5271/sjweh.2894] [PMID]

- [4] Gan Y, Yang C, Tong X. Shift work and diabetes mellitus: a meta-analysis of observational studies. *Occup Environ Med*. 2015; 72(1):72-8. [DOI:10.1136/oemed-2014-102150] [PMID]
- [5] Vyas MV, Garg AX, Iansavichus AV, Costella J, Donner A, Laugsand LE, et al. Shift work and vascular events: systematic review and meta-analysis. *BMJ*. 2012; 345:e4800. [DOI:10.1136/bmj.e4800] [PMID] [PMCID]
- [6] Proper KI, Van de Langenberg D, Rodenburg W, et al. The relationship between shift work and metabolic risk factors: a systematic review of longitudinal studies. *Am J Prev Med*. 2016; 50(5):e147-57. [DOI:10.1016/j.amepre.2015.11.013] [PMID]
- [7] Sun M, Feng W, Wang F, et al. Meta-analysis on shift work and risks of specific obesity types. *Obes Rev*. 2018; 19(1):28-40. [DOI:10.1111/obr.12621] [PMID]
- [8] Wang F, Zhang L, Zhang Y, et al. Meta-analysis on night shift work and risk of metabolic syndrome. *Obes Rev*. 2014; 15(9):709-720. [DOI:10.1111/obr.12194] [PMID]
- [9] Torquati L, Mielke GI, Brown WJ, Kolbe-Alexander T. Shift work and the risk of cardiovascular disease. A systematic review and meta-analysis including dose-response relationship. *Scand J Work Environ Health*. 2018; 44(3):229-38. [DOI:10.5271/sjweh.3700] [PMID]
- [10] Esquirol Y, Perret B, Ruidavets JB, Marquie JC, Dienne E, Niezborala M, et al. Shift work and cardiovascular risk factors: new knowledge from the past decade. *Arch Cardiovasc Dis*. 2011; 104(12):636-68. [DOI:10.1016/j.acvd.2011.09.004] [PMID]
- [11] Manohar S, Thongprayoon C, Cheungpasitporn W, Mao MA, Herrmann SM. Associations of rotational shift work and night shift status with hypertension: a systematic review and meta-analysis. *Am J Hypertens*. 2017; 35(10):1929-37. [DOI:10.1097/HJH.0000000000001442] [PMID]
- [12] Dong C, Zeng H, Yang B, Zhang Y, Li Z. The association between long-term night shift work and metabolic syndrome: a cross-sectional study of male railway workers in southwest China. *BMC Cardiovasc Disord*. 2022; 22(1):263. [DOI:10.1186/s12872-022-02705-7] [PMID] [PMCID]
- [13] Miller M, Stone NJ, Ballantyne C, Bittner V, Criqui MH, Ginsberg HN, et al. Triglycerides and cardiovascular disease: a scientific statement from the American Heart Association. *Circulation*. 2011; 123(20):2292-333. [DOI:10.1161/CIR.0b013e3182160726] [PMID]
- [14] Mohebbi I, Shateri K, Seyedmohammadzad M. The relationship between working schedule patterns and the markers of the metabolic syndrome: comparison of shift workers with day workers. *Int J Occup Med Environ Health*. 2012; 25(4):383-91. [DOI:10.2478/s13382-012-0051-5] [PMID]
- [15] Abu Farha R, Alefishat E. Shift work and the risk of cardiovascular diseases and metabolic syndrome among Jordanian employees. *Oman Med J*. 2018; 33(3):235-42. [DOI:10.3316/INFORMIT.608526966357016]
- [16] Rafeemanesh E, Rahimpour F, Afshari Saleh L. [Association between shift work and cardiovascular disease risk factors among healthcare workers of teaching hospitals of Mashhad University of Medical Science (Persian)]. *J Mashhad Univ Med Sci* 2016; 59(2): 88-96. https://mjms.mums.ac.ir/article_7336.html?lang=en
- [17] Mendis S, Puska P, Norrving B, World Health Organization. Global atlas on cardiovascular disease prevention and control. Geneva: World Health Organization; 2011. https://scholar.google.com/scholar?hl=en&as_sdt=0%2C5&q
- [18] American Heart Association. Coronary heart disease [Internet]. 2021. Available from: <https://www.heart.org/en/health-topics/consumer-healthcare/what-is-cardiovascular-disease/coronary-artery-disease>
- [19] Lajoie P, Aronson KJ, Day A, Tranmer J. A cross-sectional study of shift work, sleep quality and cardiometabolic risk in female hospital employees. *BMJ Open*. 2015; 5(3):e007327. [DOI:10.1136/bmjopen-2014-007327] [PMID]
- [20] Karlsson BH, Knutsson AK, Lindahl BO, Alfredsson LS. Metabolic disturbances in male workers with rotating three-shift work. Results of the WOLF study. *IAOEH*. 2003; 76(6):424-30. [DOI:10.1007/s00420-003-0440-y] [PMID]
- [21] Sookoian S, Gemma C, Fernández Gianotti T, Burgueño A, Alvarez A, González CD, et al. Effects of rotating shift work on biomarkers of metabolic syndrome and inflammation. *J Intern Med*. 2007; 261(3):285-92. [DOI:10.1111/j.1365-2796.2007.01766.x] [PMID]
- [22] Aslam M, Madhu S, Keithellakpam K, Mehndiratta M, Mishra B, Neh V. Longterm effects of rotational night shift work on expression of circadian genes and its association with postprandial triglyceride levels-A pilot study. *Chronobiol Int*. 2021; 38(5):629-37. [DOI:10.1080/07420528.2021.1881108] [PMID]
- [23] Dochi M, Sakata K, Oishi M, Tanaka K, Kobayashi E, Suwazono Y. Relationship between shift work and hypercholesterolemia in Japan. *Scand J Work Environ Health*. 2008;33-9. <https://www.jstor.org/stable/40967687>
- [24] Loef B, Baarle DV, Van Der Beek AJ, Beekhof PK, Van Kerkhof LW, Proper KI. The association between exposure to different aspects of shift work and metabolic risk factors in health care workers, and the role of chronotype. *PLoS One*. 2019;14(2):e0211557. [DOI:10.1371/journal.pone.0211557] [PMID] [PMCID]
- [25] Burdelak W, Bukowska A, Krysicka J, Peplowska B. Night work and health status of nurses and midwives. Cross-sectional study. *Med Pr*. 2012; 63(5):517-29. https://www.researchgate.net/profile/Beata-Peplonska-2/publication/305206587_
- [26] Ha M, Park J. Shiftwork and metabolic risk factors of cardiovascular disease. *J Occup Health*. 2005; 47(2):89-95. [DOI:10.1539/joh.47.89] [PMID]
- [27] Hulsegge G, Loef B, van Kerkhof LW, Roenneberg T, van der Beek AJ, Proper KI. Shift work, sleep disturbances and social jetlag in healthcare workers. *J Sleep Res*. 2019; 28(4):e12802. [DOI:10.1111/jsr.12802] [PMID]
- [28] Loef B, Van Der Beek AJ, Holtermann A, Hulsegge G, Van Baarle D, Proper KI. Objectively measured physical activity of hospital shift workers. *Scand J Work Environ Health*. 2018; 44(3):265-73. [DOI:10.5271/sjweh.3709] [PMID]
- [29] Guo Y, Rong Y, Huang X, Lai H, Luo X, Zhang Z, et al. Shift work and the relationship with metabolic syndrome in Chinese aged workers. *PLoS One*. 2015; 10(3):e0120632. [DOI:10.1371/journal.pone.0120632] [PMID] [PMCID]

- [30] Suwazono Y, Dochi M, Sakata K, Okubo Y, Oishi M, Tanaka K, et al. Shift work is a risk factor for increased blood pressure in Japanese men: a 14-year historical cohort study. *Hypertension*. 2008; 52(3):581-6. [DOI:10.1161/HYPERTENSIONAHA.108.114553] [PMID]
- [31] Yeom JH, Sim CS, Lee J, Yun SH, Park SJ, Yoo CI, Sung JH. Effect of shift work on hypertension: cross sectional study. *AOEM*. 2017; 29(1):1-7. [DOI:10.1186/s40557-017-0166-z] [PMID] [PMCID]
- [32] Knutsson A. Methodological aspects of shift-work research. *Chronobiol Int*. 2004; 21(6):1037-47. [DOI:10.1081/CBI-200038525] [PMID]
- [33] Pan A, Schernhammer ES, Sun Q, Hu FB. Rotating night shift work and risk of type 2 diabetes: two prospective cohort studies in women. *PLoS Medicine*. 2011; 8(12):e1001141. [DOI:10.1371/journal.pmed.1001141] [PMID] [PMCID]
- [34] Sun M, Feng W, Wang F, Li P, Li Z, Li M, et al. Meta-analysis on shift work and risks of specific obesity types. *Obes Rev*. 2018; 19(1):28-40. [DOI:10.1111/obr.12621] [PMID]
- [35] Kervezee L, Kosmadopoulos A, Boivin DB. Metabolic and cardiovascular consequences of shift work: The role of circadian disruption and sleep disturbances. *Eur J Neurosci*. 2020; 51(1):396-412. [DOI:10.1111/ejn.14216] [PMID]

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