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THE ADVERSE HEALTH EFFECTS OF SHIFT WORK IN RELATION TO RISK OF ILLNESS/DISEASE: A REVIEW

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Summary. Biological rhythm of sleeping is a natural disparity in an organism corresponding to and in reply to cyclic environmental changes, such as daylight hours and hours of darkness or elevated and low down flow. There is some evidence, based upon epidemiological studies as well as studies upon smaller groups of subjects, that individuals who work during the night and sleep during the daytime show cognitive impairment at work, have poorer and fragmented daytime sleep, and have increased risks of developing a wide range of social, psychological, physiological and medical impairments and disorders. Circadian rhythms are one of the most important effective factors on the physiological and physical performances of humans and disturbing this normal rhythm leads to different groups of diseases. The majority of investigations in biological rhythm demeanor vary noticeably in regards to the exact type of disease, population and protocols of sampling over the other outcomes or issues. We conducted a systematic review of [Science Direct, Pubmed, Scopus] to identify influence of different kinds of diseases among shift workers in response to abnormal rhythm of sleeping. The results of this review indicate that abnormal patterns of sleeping can lead to immunological issues, hypertension, metabolic syndrome, insomnia, cardiovascular disease, obesity and depression. It is vital for subsequent investigations to find a way to reduce negative effects (such as decreased amount of works' time and altered diet) without side effects to help them.

Key words: *biological rhythm; sleeping, physiological; physical; shift workers*

INTRODUCTION

Biological rhythms is an intervallic biological rise and fall in a life form parallel to and in reply to episodic ecological variations, such as day and night or elevated and lowered waves. The interior apparatus that keeps this rhythm still without the obvious ecological motivation is a"biological clock."When the tempo is broken up, the clock's modification is late, secretarial for such phenomena as jet lag when itinerant from corner to corner time zones, or working in diverse shifts and sleeping in irregular times.

Almost 20-25% of the employed labor force in developed nations involves shift works and they cannot follow the biological rhythm of sleeping. The proportion of shift workers is constantly growing in this region of the globe due to the upward financial system and enhanced worldwide transportation[1]. At present, approximately one in five workers around Europe and in the United States work on shift basis [2, 3]. Having said that, shift work is now no longer limited to such professions, but it is also observable in current call centers, wherever workers bring economic and trade services roughly the timepiece, as well as in the bank, and supermarkets [4]. It is also practiced in factories with manufacturing processes that exceed 8h, e.g. chemical factories [1]. It is hence of no surprise that 13-20% of the employees in the US and Europe work day and night shifts [3].

There is clear evidence that those who work at night, and so in opposition to the outputs of their body clock (which adjusts only poorly, if at all, to the altered sleep-wake cycle that night work requires), show negative effects of this abnormal lifestyle; these effects include poorer mental performance at night (particularly in tasks requiring cognition or vigilance), fragmented and shortened sleep during the daytime, and a whole range of negative effects upon the individual's sociology, psychology and physiology, associated with which are increased risks of the development of several medical disorders.

Demands created by biological rhythm of sleeping among shift workers are broadly varied depending on the schedule, age and fitness level of the workers. It is comparatively understood that following the biological rhythm of body is vital to maintain good health. However, many side effects that disrupt this biological rhythm among shift workers stay put uncharted. By means of such a huge number of shift workers, the industries and governments should be able to supply practical advices to shift workers who suffer from diseases related to their abnormal rhythm of sleeping. Therefore, efficacy of prescription strategies to better the health level and reduce the risks of diseases and injuries among shift workers has become a field of intrigue amongst health scientists.

What will be happen if we do not follow the biological rhythm? Is there any relation among biological rhythm and physiological and physical performances?

Researches have time after time exposed that shift and night employment may cause more than a few hazards to workers. They rationalize shift work broadmindedness as the nonattendance of troubles frequently linked with shift work, such as digestive dilemma, persisting fatigue and sleep alterations[5].

Are the shift workers really more prone to infections, chronic diseases and finally…death? One of the most important issues surrounding shift work is, biological disturbance of the physiological process[6], as well as the sleep-wake-cycle can result from shift work [7].

Unluckily, data exploratory the side effects of abnormal rhythm of sleeping among shift workers are comparatively limited[8]. The preponderance studies that contract with the side effects of shift working on healthiness have been conduct by means of clinical-base sampling. For instance, Thomas C Erren et al evaluated effects of shift working and abnormal rhythm of sleeping on health parameters[9]. However, there are considerable physical and physiological differences among the shift workers and also differences in the time of their shifts.

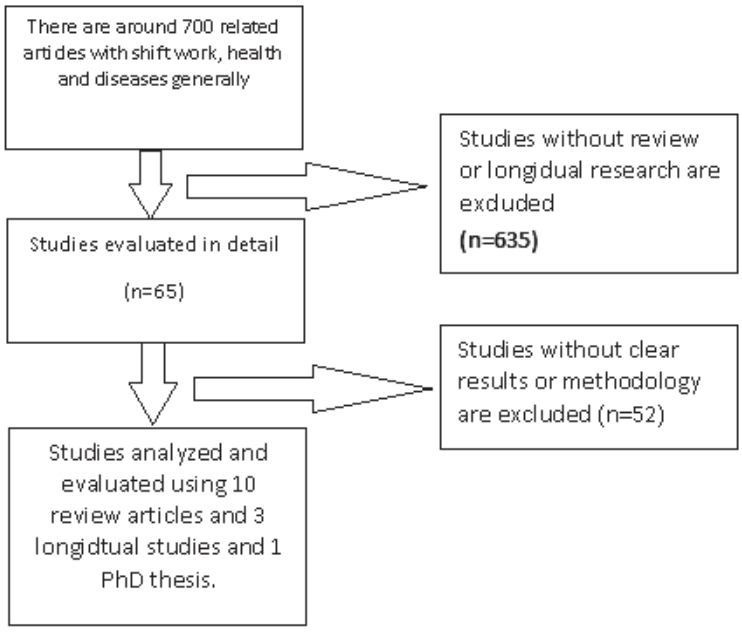
For the purpose of this article, shift workers are defined as workers who change their working schedule and don't follow the biological rhythm of sleeping during the night. Diseases in response to this abnormal rhythm vary widely, from the workers who change the time of working every day up to the workers, who change the shifts every month. It is this unpredictability in shifts and a wide range of diseases related to abnormal rhythm of sleeping that not only highlight the importance of these side effects other than provide details on potential challenges while interpreting information from previous researches.

Based on the growing rate of diseases and death as well as a rise in the number of shift workers throughout the world, it is vital to recognize the issues related to shift work [6]. Therefore, the point of this article is to systematically scanreview accessible data linked to the usefulness of a range of side effects of abnormal rhythm of sleeping, argue possible limits of the said-cited literature, and provide advice on instructions for future researches specific to biological rhythm of sleeping and related issues among shift workers. Additionally, realistic applications of the argument will be on hand for the companies and governments because often they may have incomplete information of biological rhythms or are uninformed of current studies.

MATERIALS AND METHODS

In this study, systematic review methods are used based on the purpose of research. A systematic investigation of recurrent literature databases was navigated between 2003 and 2014. Science Direct, Pubmed, Scopuswere were searched for the subsequent key words: shift work, biological rhythm of sleeping, diseases, physiological issues, physical issues and field study. Papers were also recognized and used by the chief author's collected works. Initially 700 researches were recognized (Table 1). As there are a huge number of researches about shift working and related diseases, we could not analyze all the original articles, so we analyzed and reviewed previous researches. It is notable that there is a lack of review research from 2005 till 2010. After the year 2010, the number of review articles in this field is increased. So in our review, there are 2 reviews published during 2003-2005 and the others are published after 2010, Of course as there was a valuable review in 1999 and almost all the reviews after 2010 referred to it, we add it to our list. There was only one PhD thesis published in 2011 that covered all aspects of shift working, and we used it, too. In this review we also have surveyed 3 last related longitudinal studies dated 2005, 2008 and 2011, respectively. In some cases, based on the importance of the study, we have incorporated the original articles that were cited in the previous review articles. Moreover, it must be noted that, the results of this review are dictated by our search terms.

Table 1. Number of selected works with chief author



Documents are integrated if the review article was published after 2003 and this also applies to longiditual studies published after 2005 that were carried out on shift workers who had irregular rhythm of sleeping.

Clinical studies are integrated as well. Participants had no injuries and did not use any medications. Terms of methodology (theory building, research method, sample size, sampling, measurement instruments, reliability and validity of measurement instrument, statistical theory, statistical analysis and being correct statistical calculation) are taken into consideration as well. Investigation will be conducted as a group study (it was not based on Case or single test). Studies were excluded if they deficit a gauge of sleeping times and also lacked a definition of diseases in response to shift working and irregular rhythm of sleeping. In addition, studies without methodological conditions are excluded, too.

RESULTS

Presented in Table 1 is a summary table outlining the key analyzed article, with the number of subjects and the diseases that were measured from the literature.

Cardiovascular Issues

A link between shift work, abnormal rhythm of sleeping and cardiovascular illness has been hypothesized and tinted more and more in current existence, other than which cannot be resolutely defended. A freshly available summing up of the literature focusing on ischemic heart illness and based on 16 studies (1972-2008) did not bring to a close with confidence that shift work has crashed [10]. Generally, similar consequences were recently seen from a 22-year period of note-taking conducted by a Finnish legion that analyzed death outstanding to coronary heart illness in both genders [11].

According to some reviews, shift work and abnormal rhythm of sleeping are associated with ischemic heart disease [12], breast cancer [13], sleep disturbances [14], gastrointestinal disorders [15], negative pregnancy outcomes [16], and metabolic disorders [17]. In this table we have summarized the result of 10 articles that we have reviewed as well as their results.

Immunological Parameters

The homeostatic regulation of the motion and appearance of multiple immune cells can be determined based on the influence of the circadian sleep wake rhythm. Human Peripheral Blood Mononuclear Cell (PBMC) subsets exhibit diurnal rhythms whilst in the state of normal circadian and sleep wake conditions. These heights can reach a summit either in daylight – such as in neutrophils or natural-killer (NK) cells that play a significant part in phagocytosis, or in nocturnal hours – such as in monocytes [18]. In short, the rates of the conditions vary according to cell. Additionally, the presence of cytokines in blood, excluding that of interleukin (IL)-6 is especially low when physiological conditions are in standard shape. Diurnal rhythms for a range of cytokines–notably IL-6, IL-12 or the Tumour Necrosis Factor (TNF)-a, which peaks in value during sleeping hours at night, and also for the leukocyte subset cells – such as monocytes – from which they originate, have all been featured in several human studies [18].

Blood-level measurements of cytokine and its main source monocyte have been obtained through the practice of inconsistent routine situations used in many sleep manipulation studies. With reference to an early shift work study by Nakano et al, the examination of immune and inflammatory biomarker changes in the attributes of shift work on cellular immune role has deduced that shift workers display a decrease in lymphocyte propagation ability in comparison with daytime workers [19]. A later research in 2002 by Nagaya and co-workers on 89 Japanese emergency physicians and the activity of their NK cells – basically nonspecific immune cells

that can distinguish external bodies or matter, including viruses–has proven that NK cell activity is less prominent among nightshift workers at their initial hour of duty[20].

Shift workers have also been shown to possess a higher count of leukocyte in comparison with day workers, with reference to several cross-sectional reports on blood leukocyte levels [21]. An initial research in 2009 by De Bacquer and colleaguescarried out on 208 male Japanese workers with no previous record of contracting an inflammatory disease (107 daytime workers; 101 shift workers; age: 33.7_12.3y) surprisingly forged a link between bad sleeping habits and a surge in leukocyte counts [22].

One other intriguing research, involving 1877 employees of an airline company, revealed after analysing factors such as educational background, physical stamina, body mass index, alcohol consumption and smoking habits, that both male and female shift workers are susceptible to increased leukocyte counts due to their shared work pattern.

In brief, Immunological disruption is associated with heart attacks, stroke, obesity, cancer, etc. Additionally, shift work was recently classified as a probable carcinogen by decreasing leukocyte blood level.

Metabolic Syndrome and Diabetes

Metabolic syndrome can best be defined as a collective term for several risk factors including high blood pressure, central obesity, lowered high-density lipoprotein cholesterol, high fasting glucose and high triglycerides, all of which are frequently present simultaneously in an individual. It has been revealed through a pioneer study in2010 by Chen, Lin and Hsiao that unlike day workers, shift workers are gravely vulnerable to three metabolic syndrome gadgets, namely high triglycerides, obesity and hypertension [23]. Burgueño et al in 2010 have also discovered that a heightened susceptibility to metabolic syndrome among nightshift healthcare workers is a result of poor sleeping and resting habits aside from their nocturnal working hours [24]. Similar results could be seen in a 2011 research by X. S. Wang et al carried out on police officers, too. However, this particular study may not be directly comparable with other researches carried out on day shift workers with a more regular schedule because the officers` daytime shifts began at 4 in the morning [25]. Nevertheless, it is undeniable that the latest past studies have affirmed the existence of a link forged between shift work, biological rhythm of sleeping and metabolic syndrome in spite of a few bewildering parameters [26].

A connection between a heightened vulnerability to diabetes and shift work has been suggested as well, but there are few epidemiological findings to corroborate this hypothesis. An initial cross-sectional study of Japanese male factory workers in 2011 by X. S. Wang et al shows that shift workers are more vulnerable to diabetes than day workers in an aggregated ratio of 2.1% to 0.9%, but in a similar research on Japanese male blue-collar workers by Nagaya et al, the susceptibility to diabetes among shift workers varies according to age. It is not easy to comprehend published data on metabolic syndrome and diabetes because of factors such as ambiguities in submitted information; incomparable shift work logos as well as irrelevant emphasis on insignificant rises in risks/positive outcomes in group analyses, lack of or unclassified forms of adjustments and the absence of a reliable description of metabolic syndrome [27].

Obesity and Physical Characters

It is well-known that healthy lifestyle and exercise improve health. Physical activity is often of the leisurely sort where such researches are concerned. On the other hand, it is also imperative to incorporate physical labor as part of physical activity on the whole. To substantiate this argument, a 20-year long monitoring of 26643 hypertensive Finnish citizens shows that the subjects experience lower risks of dying from cardiovascular diseases after analyzing the extent of their physical labor, level of education, behavioral habits, age, BMI, SBP, cholesterol levels and leisurely physical activities [28].

A 2008 study by Willis, O` Connor and Smith has found that while shift workers have a larger share of physical labor, it does little to either better worsen their susceptibility to cardiovascular diseases that have been linked to their pattern of working hours [29]. Coincidentally, Härmä and co-workers (2006) have discovered that both day and nightshift workers engage themselves in an equal amount of time devoted to leisurely physical activities [30]. Nevertheless, there are also several publications that tend to exaggerate on sedentary activities among shift workers (Willis, O` Connor and Smith, 2008), which makes social organisation among shift workers potentially arduous.

Harrington (2001) speculates that obesity may be the bridge between shift work and metabolic turbulence. He believes that this can potentially result in diabetes and cardiovascular ailments. More recent researches have subsequently emphasised on the discovery of a connection that binds obesity with shift work [31]. A 2007 study by Jeppesen, and Bøggild [32] involving 5038 shift workers and 1999 day workers reveals that obesity affects 9.6% of the former and 8.5% of the latter, whereas Knutsson (2003) have in two cross-sectional studies shown through an analysis of the VIP study that shift workers exhibit a serious 1.4-fold higher risk of obesity, irrespective of gender [15]. On the other hand, such findings tend to be dubious as they do not conform to the WOLF study that also includes other confounding factors such as physical activity and tobacco consumption [33].

An uneven BMI, often reflected in wider girths or circumference of the waist, is also remotely connected to shift working in several researches [34], although contrary findings have been deduced by Ryan et al in 2008, whereas others could not draw a link between the two. Last but not least, a bond between the extent of engagement in shift work patterns in the context of time and weight gain has been hypothesised in a number of researches, too [35].

In a nutshell, the majorityof longitudinal researches end in the direction of an update on shift work onincreases in BMI.On the contrary, given the consequences of additional researches, it is not easy to declare this connection.

DISCUSSION

Earlier investigations has revealed that shift work and irregular rhythm of sleeping may be linked with harmful health outcomes, although the epidemiological proof for a fundamental association is often inadequate, meaning that “a fundamental relative is probable…but it is not doubtful that this connection can be explained by possibility, prejudice or confusing” [36]. This review aims to sum up and emphasize on the issues and diseases related to irregular rhythm of sleeping and shift working.

The researchers mentioned in this review originate from a host of different countries. The body of facts suggests that, for populations where records are obtainable, shift workers hardly ever have check-ups and they suffer from diseases. A significant finding is that a superior risk of cardiovascular diseases, immunological issues, diabetes and metabolic syndrome are applicable among shift workers who do not have a regular pattern of sleeping. Even though some of them are aware of these risk factors, there is not a clear method to reduce these issues. Other factors, such as economic and employment pressures as well as those associated to look closely into group influences, may also pressure risk factors related to model of sleeping [9, 37].

There is some evidence to propose that latent gender differences can be recognized. For example, male workers tend to be distinguished based on advanced levels of health risk factors related to shift working and irregular rhythm of sleeping, and they also display less cynical behaviors [38]. On the other hand, this verdict can be passed in other geological regions and cultures as a way of differentiating between developed, developing and undeveloped countries.

This is in line with a freshly available general idea of the literature concentrating on ischemic heart illness and is rooted in 16 researches (1972-2008) but did not bring to a close with confidence that shift work has crashed [26]. In addition to that, in the US, sources from the Bureau of Labor Statistics in 2004 affirmed that 15% of US human resources were engaged in shift work [39].

Elevated levels of information and insights into risks are not sufficient to pressure workers and operators` suspicious actions. This must be well thought-out when scheming a proper working and resting time schedule to boost their safety. Other financial and socio-cultural pressures may also necessitate to be explained. These might take in financial and service pressures. The pressure of potentially powerful peer groups may also need to be mentioned in risk communiqué initiatives heading for at both employers and workers [40, 41].

Gaps in knowledge that need to be addressed in future researches have also been identified. In particular, research is needed to better understand the risk factors and related attitudes and knowledge levels about abnormal rhythm of sleeping associated with shift workers.

As the previous researches were done only on one group of issues, equivalent research and then gathering all the relevant results are needed to inform the workers and government to develop the equipment for resting and natural ways to reduce the side effect of abnormal rhythm of sleeping among growing population of shift workers [42].

The confirmation advices that it may be essential to take sexual characteristics differences into description, as females are extensively concerned in shift behaviors in many parts of the globe and can be tremendously susceptible to unfavorable health belongings of irregular rhythm of sleeping, and also potentially have dissimilar levels of hazard factors, and schooling compared to males. At the same time, the facts for a fundamental association flanked by risk factors and related approach are ambiguous.

A number of confines of this review ought to be acknowledged as well. The authors admit that the insertion of papers written only in English could have led to the inevitable exclusion of notable articles that were written in other languages. The authors believe that such literatures may be obtainable only in the native languages of the researchers, for instance in Japanese or German. On the other hand, it is obviously not probable to comprise all possible applicable publications in other languages in a review owing to first of all the unfeasibility of systematically identifying all such papers, and because of the linguistic confinements of the databases accessed. An additional curb to recognition of researches for enclosure may narrate to the databases utilized, as not all journals are obtained from built-in data-bases. In this research, we have incorporated those that have been generally used for reference in the field of research. We are logically convinced, consequently, that the review has integrated a variety of obtainable academic English-language researches, even though there possibly will be some omissions linked to the data-bases chosen.

It has been hypothesized that greater domains of circadian rhythms result in a superior ‘stability’, that possibly will be helpful for coping by means of normal rhythm commotion (although this, on more than one occasion, would appertain to types of shift agreement) [43, 44]. A host of scientists have discovered that the beat domains of physically healthy or physically energetic persons are higher than those possessed by out-of-form or inactive subjects [4, 44, 45], However, these suggestive contacts are highly confounding and complex. The fact that a rhythm domain of this vast a magnitude could be influenced by the physiological version within a more superior context, or “synchronised” by a consistent physical activity and thus inciting a more pronounce experiential rhythm, remains uncertain [46]. Nevertheless, a silver lining exists; such a gap may provide a new research topic for future scholars.

The diseases and issues linked to shift workers who are older than 50 or shift workers who are generally energetic and exercise regularly are tinted in other researches. These

issues have been disqualified from the existing review, which only focuses on shift workers who are deskbound and aged between 20-50 years, and subsequently tries to highlight their heath issues.

Usual physical activity is measured using a foundation stone in the avoidance and organization of hypertension. Epidemiological researches point out that superior physical activity or fitness is linked to an inferior blood pressure (BP), and meta-analyses of randomized controlled trials have exposed that constant dynamic aerobic endurance training is able to reduce BP. The most important result of the meta-analysis of randomized controlled trials by Chobanian on the special effects of constant dynamic aerobic endurance training are: [47][26] that training lowers BP and that the net BP reply is more marked in hypertensive than in non-hypertensive; [48, 49], that the decrease in BP is based on a diminish in SVR, in which the sympathetic nervous system and the renin-angiotensin system come into view; and [50, 51], that training is related to constructive property on additional cardiovascular risk factors.

The acceptance of analogous needy variables in prospective researches would make proper reviewing easier and permit significant testing of differences in time and subjects sandwiched between different geological regions [52].

CONCLUSION

The present review of the scientific literature confirms that problems widely accepted to exist in those who perform night work have been consistently found in research and epidemiological studies. The main problems seem to be: fragmented daytime sleep; increased risks of developing cardiovascular, gastroenterological, haematological and immunological disorders; increased risk of suffering from metabolic syndrome and diabetes mellitus; and the development of obesity. Causal links can be difficult to establish (few suitable intervention studies having been performed) but altered diet, decreased amounts of physical activity and reduced sleep seem to be the main factors that cause concern.

The authors acknowledge the difficulties of laboratory and field settings. Shift workers are a group of scandalously tricky residents to study because many are disinclined to modify their diseases to put up with physiological and physical testing or have a small wish to explain in better detail about their behaviors and lives. Besides, nearly all of them occupied with their work most of the time. Most researches have not sufficiently sorted the existing related diseases of their subjects, so it can be tricky to understand an author's description of "related disease to shift work" vs. "healthy working". Additionally, the subjects belonged to different age groups, levels of fitness and genetic profiles. Therefore, age, level of fitness, medical history, personal bests, and other demographic statistics should be presented by scientists in further researches. In conclusion, gender differences ought to be measured in terms of the structural, hormonal, and metabolic differences common in both men and women.

REFERENCES

1. Faraut B, Bayon V, Léger D. Neuroendocrine, immune and oxidative stress in shift workers. Sleep medicine reviews, 17, 2013, 433-44.
2. Scott A, LaDou J. Health and safety in shift workers. Occupational Medicine, 1994, 960-71.
3. Harrington JM. Health effects of shift work and extended hours of work. Occupational and Environmental medicine, 58, 2001, 68-72.
4. Atkinson G, Fullick S, Grindey C, Maclaren D. Exercise, energy balance and the shift worker. Sports Medicine, 38, 2008, 671-85.
5. Saksvik IB, Bjorvatn B, Hetland H et al. Individual differences in tolerance to shift work–a systematic review. Sleep medicine reviews, 15, 2011, 221-35.

6. Schaufeli WB, Taris TW. A critical review of the Job Demands-Resources Model: Implications for improving work and health. Bridging occupational, organizational and public health: Springer, 2014, 43-68.
7. Monk TH, Folkard S. Making shiftwork tolerable: CRC Press, 1992.
8. Arendt J. Shift work: coping with the biological clock. Occup. Med., 60, 2010, 10-20.
9. Erren TC, Herbst C, Koch MS et al. Adaptation of shift work schedules for preventing and treating sleepiness and sleep disturbances caused by shift work. The Cochrane Library, 2013.
10. Hublin C, Partinen M, Koskenvuo K et al. Shift-work and cardiovascular disease: a population-based 22-year follow-up study. Eur. J. Epidemiol., 25, 2010, 315-23.
11. Bøggild H, Knutsson A. Shift work, risk factors and cardiovascular disease. Scand. J. Work Environ. Health, 1999, 85-99.
12. Lyon F. IARC monographs on the evaluation of carcinogenic risks to humans, 1982.
13. Kolstad HA. Nightshift work and risk of breast cancer and other cancers – a critical review of the epidemiologic evidence. Scand. J. Work, Environ. Health, 2008, 5-22.
14. Barger LK, Lockley SW, Rajaratnam SM et al. Neurobehavioral, health, and safety consequences associated with shift work in safety-sensitive professions. Curr. Neurol. Neurosc. Rep., 9, 2009, 155-64.
15. Knutsson A. Health disorders of shift workers. Occup. Med., 53, 2003, 103-8.
16. Lowden A, Moreno C, Holmbäck U et al. Eating and shift work-effects on habits, metabolism, and performance. Scand. J. Work, Environ. Health, 2010, 150-62.
17. Åkerstedt T. Altered sleep/wake patterns and mental performance. Physiology & Behavior, 90, 2007, 209-18.
18. Karlsson B, Knutsson A, Lindahl B. Is there an association between shift work and having a metabolic syndrome? Results from a population based study of 27 485 people. Occup. Environ. Med., 58, 2001, 747-52.
19. Kawakami N, Haratani T, Araki S. Job strain and arterial blood pressure, serum cholesterol, and smoking as risk factors for coronary heart disease in Japan. Int. Arch. Occup. Environ. Health, 71, 1998, 429-32.
20. Nagaya T, Yoshida H, Takahashi H, Kawai M. Markers of insulin resistance in day and shift workers aged 30-59 years. Int. Arch. Occup. Environ. Health, 75, 2002, 562-8.
21. Hu G, Jousilahti P, Antikainen R, Tuomilehto J. Occupational, commuting, and leisure-time physical activity in relation to cardiovascular mortality among Finnish subjects with hypertension. American journal of hypertension, 20, 2007, 1242-50.
22. De Bacquer D, Van Risseghem M, Clays E et al. Rotating shift work and the metabolic syndrome: a prospective study. International journal of epidemiology, 38, 2009, 848-54.
23. Chen J-D, Lin Y-C, Hsiao S-T. Obesity and high blood pressure of 12-hour night shift female clean-room workers. Chronobiol. Int., 27, 2010, 334-44.
24. Burgueño A, Gemma C, Gianotti TF et al. Increased levels of resistin in rotating shift workers: a potential mediator of cardiovascular risk associated with circadian misalignment. Atherosclerosis, 10, 2010, 625-9.
25. Wang X, Armstrong M, Cairns B et al. Shift work and chronic disease: the epidemiological evidence. Occup. Med., 61, 2011, 78-89.
26. Frost P, Kolstad HA, Bonde JP. Shift work and the risk of ischemic heart disease-a systematic review of the epidemiologic evidence. Scand. J. Work Environ. Health, 2009, 163-79.
27. Gumenyuk V, Roth T, Drake CL. Circadian phase, sleepiness, and light exposure assessment in night workers with and without shift work disorder. Chronobiol. Int., 29, 2012, 928-36.
28. Knutsson A, Akerstedt T. The healthy-worker effect: self-selection among Swedish shift workers. Work & Stress, 6, 1992, 163-7.
29. Willis TA, O'Connor DB, Smith L. Investigating effort–reward imbalance and work-family conflict in relation to morningness–eveningness and shift work. Work & Stress, 22, 2008, 125-37.
30. Härmä M. Workhours in relation to work stress, recovery and health. Scand. J. Work Environ. Health, 2006, 502-14.
31. Albertsen K, Grimsmo KAKKA, Rafnsdóttir BASGL, Tómasson K. Working Time Arrangements and Social Consequences: What Do We Know?: Nordic Council of Ministers, 2007.
32. Smith L, Jeppesen HJ, Bøggild H. Internal locus of control and choice in health service shift workers. Ergonomics, 50, 2007, 1485-502.
33. Curti R, Radice L, Cesana G et al. Work stress and immune system: lymphocyte reactions during rotating shift work. Preliminary results. La Medicina del lavoro, 73, 1981, 564-9.
34. Barton J, Smith L, Totterdell P et al. Does individual choice determine shift system acceptability? Ergonomics, 36, 1993, 93-9.

35. Ryan B, Wilson JR, Sharples S et al. Rail signallers' assessments of their satisfaction with different shift work systems. Ergonomics, 51, 2008, 1656-71.
36. Nabe-Nielsen K. Shift Work, Health, and Well-being Among Eldercare Workers: Ph. D. Thesis: Faculty of Health Sciences, University of Copenhagen, 2011.
37. Costa G, Haus E, Stevens R. Shift work and cancer – considerations on rationale, mechanisms, and epidemiology. Scand. J. Work, Environ. Health, 2010, 163-79.
38. Cabrera NL, Leckie JO. Pesticide risk communication, risk perception, and self-protective behaviors among farmworkers in California's Salinas Valley. Hisp. J. Behavi. Sci., 31, 2009, 258-72.
39. Esquirol Y, Perret B, Ruidavets JB et al. Shift work and cardiovascular risk factors: new knowledge from the past decade. Arch. Cardiovasc. Dis., 10, 2011, 636-68.
40. Van Drongelen A, Boot CR, Merkus SL et al. The effects of shift work on body weight change – a systematic review of longitudinal studies. Scand. J. Work Environ. Health, 2011, 263-75.
41. Wang F, Yeung K, Chan W, et al. A meta-analysis on dose-response relationship between night shift work and the risk of breast cancer. Ann. Oncol., 24, 2013, 2724-32.
42. Backé E-M, Seidler A, Latza U et al. The role of psychosocial stress at work for the development of cardiovascular diseases: a systematic review. Int. Arch. Occup. Environ. Health, 85, 2012, 67-79.
43. Holtermann A, Mortensen OS, Burr H et al. Long work hours and physical fitness: 30-year risk of ischaemic heart disease and all-cause mortality among middle-aged Caucasian men. Heart, 96, 2010, 1638-44.
44. Roelen CA, Bültmann U, Groothoff J et al. Physical and mental fatigue as predictors of sickness absence among Norwegian nurses. Res. Nurs. Health, 36, 2013, 453-65.
45. Chtourou H, Hammouda O, Souissi H. et al. Diurnal variations in physical performances related to football in young soccer players. Asian journal of sports medicine, 3, 2012,139-147.
46. Shariat A, Kargarfard M, Tamrin SBM et al. Strength-training and biological rhythm of male sex hormone among judoists. Biol. Rhythm Res., 2014, 1-7.
47. Chobanian A. Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. National Heart, Lung, and Blood Institute; National High Blood Pressure Education Program Coordinating Committee: Seventh report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Hypertension, 42, 2003, 1206-52.
48. Committee G. 2003 European Society of Hypertension–European Society of Cardiology guidelines for the management of arterial hypertension. J. Hypert., 21, 2003, 1011-53.
49. Parati G, Stergiou G, Asmar R et al. European Society of Hypertension practice guidelines for home blood pressure monitoring. J. Human Hypert., 24, 2010, 779-85.
50. Colberg SR, Sigal RJ, Fernhall B et al. Exercise and Type 2 Diabetes The American College of Sports Medicine and the American Diabetes Association: joint position statement executive summary. Diab. care, 33, 2010, 2692-6.
51. Franklin BA, Fagard R. Position stand. Medicine & Science in Sports & Exercise, 195, 2004, 3603-0533.
52. May T. Qualitative research in action: Sage, 2002.

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