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# Effect of Shift-Work on Hypertension Among Factory Workers in Ethiopia

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**Abstract:** Background: Shift work is associated with several health problems, possibly due to an impairment of biological rhythms. Some studies reported that changes in blood pressure regulation among shift workers could lead to chronic hypertension. So this study aimed to determine and compare the level of and risk factors for hypertension among shift and day time workers. Methods: A comparative cross-sectional study of 830 current factory workers (413 shift workers and 417 day time workers) who have worked for at least five years was conducted in Wonji Shoa sugary factory, Ethiopia. Data were collected using a pretested structured questionnaire, and blood pressure was measured using standardized instruments by trained clinical nurses. Hypertension was defined as having Systolic BP  $\geq 140$  mmHG or Diastolic BP  $\geq 90$ mmHG or reported use of regular anti-hypertensive medications prescribed by professionals for raised BP. Multiple logistic regressions were fitted and Odds ratios with 95% confidence intervals were calculated to identify independently associated factors. Results: shift work, older age, higher income quintile, and family history of hypertension were found to be independently associated with Hypertension. The prevalence of hypertension was significantly higher among shift workers compared to daytime workers (42.9% versus 30.0%;  $p$ -value $<0.05$ ). Multivariate analysis revealed the odds of being hypertensive among shift workers persists even after controlling for potential confounders including age, income, and family history of hypertension. [AOR (95% CI) = 1.48 (1.02, 2.14)]. Shift workers were also significantly more likely to be smokers compared to day-time workers (6.5 % versus 13.1 %;  $p$ -value $<0.001$ ). Conclusions: shift work, older age, higher income quintile, and family history of hypertension were found to be independently associated with Hypertension. The finding calls for institutionalization of efficient health screening and regular checkups as well as interventions promoting healthy lifestyles among shift workers.

**Keywords:** Hypertension, Shift Work, Factory Workers

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## 1. Introduction

Shift work refers to work patterns that extend beyond the conventional 8-hour work day and that potentially disrupt workers' normal biological and/or social diurnal rhythms. The varieties of shift work include permanently displaced work hours, rotating shift work, and unscheduled work hours [1]. Of these, rotating night shifts are particularly disruptive for sleep, wakefulness, eating patterns, and social activities[2]. Rotating night shifts also are associated with reduced job-related performance and higher levels of perceived stress [3, 4].

Shift work is associated with several health problems, possibly due to an impairment of biological rhythms. In

particular, an increased risk of coronary heart disease (CHD) among shift workers with a direct association between relative risk for CHD and time of exposure to shift work has been reported in previous studies [5, 6].

Additionally, several studies have reported a higher prevalence of coronary risk factors among rotating shift workers, including increased cigarette consumption, higher blood pressure, and increased serum cholesterol, glucose, and uric acid levels and urinary adrenaline excretion[7].

Despite the biological plausibility and evidence from short term studies, there are very few studies that reported changes in blood pressure regulation among shift workers could lead to chronic hypertension [8]. For instance, in a Japanese cohort study, habitual shift workers of a steel company had

higher systolic and diastolic blood pressure than habitual daily workers [7]. In contrast the Finnish Twin Cohort [9], and a survey from Brazil [10] showed no association between the usual period of work and incidence and prevalence of hypertension respectively.

Until recently, the prevention and control of hypertension has not received due attention in many developing countries including Ethiopia; although it is one of the most modifiable risk factors for cardiovascular diseases. However, awareness about treatment and control of hypertension is extremely low among developing nations including Ethiopia, especially in relation to work and work related problems like shift work. In these countries health care resources are overwhelmed by other priorities including HIV/AIDS, tuberculosis, and malaria [19].

However, recent evidences indicate that hypertension and raised blood pressure are increasing partly because of the increase in risk factors including smoking, obesity, and harmful use of alcohol and lack of exercise [19]. But, little is known about the magnitude and determinants of hypertension in relation to in the shift workers in most developing countries including Ethiopia.

Even though there are no recent data on the number of shift workers in Ethiopia and other low income countries, it is clear that significant segment of the workforce is working in this setting. With many grand development initiatives and increasing industrialization, the number of shift workers is bound to increase to meet the needs for time-flexibility of the workforce that is key to optimize productivity and competitiveness [28]. Hence, it is timely to explore the burden and differentials of hypertension among shift and day time workers in Ethiopia and design appropriate strategies.

Thus, this study aimed to identify the effect of shift work on hypertension among factory workers in Ethiopia.

## 2. Methods and Materials

### 2.1. Study Design and Participants

A comparative cross-sectional study was conducted among randomly selected day time and shift workers in Wonji Shoa sugar factory; one of the oldest agro industries in Ethiopia. Study participants were permanent employees of the sugar factory who have been working there at least for 5 years and those who had eight hour shift in a regular manner. Workers were stratified by their work pattern as shift and day time workers, and Study participants were selected from each group using simple random sampling. Excluding subjects with incomplete information (n=6) the final sample size included 830 (413 shift workers and 417 day time workers). All shift workers were working three shifts rotating every week. This study was conducted in accordance with the STEP- wise approach of the World Health Organization (WHO) for NCD surveillance in developing countries [11]. The approach has three levels: (1) questionnaire to gather demographic and behavioral information, (2) physical measurements, and (3) biochemical tests. The present study

used the first 2 steps; questionnaire survey and anthropometric and blood pressure measurement.

### 2.2. Data Collection and Variable Specification

Participants were interviewed by trained interviewers using the WHO STEPS-structured questionnaire. In accordance with the STEPS manual, questions related to alcohol and substance use were tailored to reflect the local context of Ethiopia [11]. The questionnaire was first written in English, translated into Amharic by experts, and translated back into English by a panel of professionals who speak both languages. The questionnaire was pretested before the initiation of the study and contained information regarding socio-demographic characteristics, tobacco and alcohol use, and nutritional status. A three-days training of the contents of the STEPS questionnaire, data collection techniques, and ethical conduct of human research was provided to research interviewers prior to the commencement of the study.

Blood pressure (BP) was measured using a digital measuring device with participants sitting after resting for at least five minutes. Two BP measurements were taken with at least three minute intervals between consecutive measurements. The mean systolic and diastolic BP from the first and second measurement was analyzed [11]. The measurement was taken with each subject sitting on a chair and supported hand. The measurement was taken early in the morning from 7am- 10 am and in the afternoon after 4pm in a calm environment. Hypertension was defined as mean systolic blood pressure (SBP)  $\geq$  140 mmHg or mean diastolic blood pressure (DBP)  $\geq$  90 mmHg.

All subjects provided informed consent, and all research protocols were approved by the Institutional Review Boards of Addis Ababa university school of public health, Addis Ababa, Ethiopia.

### 2.3. Statistical Analyses

Data were entered into EPI INFO (Version 3.5.1), and exported to SPSS (Version 16.0) for statistical analysis. We first explored frequency distributions of socio demographical and behavioral characteristics of subjects and Descriptive statistics was used to summarize and present the information in the form of mean, median, percentages and tables with 95% confidence intervals for prevalence estimates. Binary logistic regression analysis was used to examine the association between shift work and hypertension adjusting for other potential confounders. Both crude and adjusted odds ratio are presented with a 95% confidence interval. A p-value of less than 0.05 was used to define statistical significance.

## 3. Results

Demographic and lifestyle characteristics of the study population are provided in Table 1. Four hundred thirteen (49.8%) of the respondents were shift workers with shift to day time workers ratio to of 1:1. Six hundred seventy nine (81.8%) of the participants were males. Males constitute

378(91.5%) and 301(72.2%) among shift and non-shift workers respectively. Non shift workers were significantly more likely to be younger than night shift workers (mean (sd) age = 39±10 years versus 42±10 years; p-value<0.01). Regarding educational status, Non shift workers were significantly more likely to have tertiary (diploma and above)

education compared to shift workers (32.2% versus 19.4%; p-value<0.001). Majority of shift workers (59.8 %) worked for more than 15 years. Only ninety six (23.0%) day time workers and 59(14.0%) of shift workers belong to the highest wealth quintile.

**Table 1.** Socio-demographic characteristics of day time and shift workers in Wonji Shoa sugar factory, Ethiopia, January 2012 (n=830).

Variable	Non-shift workers	Shift workers	Total	P- Value
	No (%)	No (%)	No (%)	
Sex				
Male	301(72.2)	378(91.5)	679(81.8)	<0.001
Female	116(27.8)	35(8.5)	151(18.2)	
Age				
20-29	80(19.2)	52(12.6)	132(15.9)	0.001
30-39	131(31.4)	114(27.6)	245(29.5)	
40-49	131(31.4)	128(31.0)	259(31.2)	
>50	75(18.0)	119(28.8)	194(23.4)	
Educational status				
Primary (1-8)	136(32.6)	214(51.8)	350(42.2)	<0.001
Secondary (9-12)	147(35.3)	119(28.8)	266(32.0)	
Tertiary (more than 12)	134(32.2)	80 (19.4)	214(25.8)	
Average monthly income(quintile)				
<600 ETB	81(19.4)	91(22.0)	172(20.7)	0.004
601-1040 ETB	81(19.4)	85(20.6)	166(20.0)	
1041-1600 ETB	68(16.3)	96(23.2)	164(19.8)	
1601-2400 ETB	91(21.8)	83(20.1)	174(21.0)	
2401 -7000 ETB	96(23.0)	59(14.0)	154(18.6)	
Work experience in the factory				
5-10 years	121(29.0)	63(15.3)	184(22.2)	<0.001
11-15 years	80(19.2)	98(23.7)	178(21.4)	
16-22 years	70(16.8)	67(16.2)	137(16.5)	
23-30 years	85(20.4)	100(24.2)	185(22.3)	
>30 years	61(14.6)	85(20.6)	146(17.6)	
Smoking habit				
Smoker	27(6.50)	54(13.1)	81(9.8)	0.001
Non smoker	390(93.5)	359(86.9)	749(90.2)	
Alcohol drinking				
Yes	77(18.5)	110(26.6)	187(22.5)	0.005
No	340(81.5)	303(73.4)	643(77.5)	

Figure- 1 shows the prevalence of hypertension among day and shift workers. The overall prevalence of hypertension in the study participants is 36.4% (95% CI 33.1%, 39.7%). Shift workers were significantly more likely to have hypertension than day time workers [177(42.9%) versus 125(30.0%); p-value<0.001].

Among those who had hypertension 73(58.4%) of day time workers and 115(65.0%) shift workers were diagnosed during the survey for the first time; the rest (41.6% from day time workers and 35.0% from shift workers) were already on treatment for hypertension. Close to one-third of study participants (30.8%) diagnosed to have hypertension had a family history of hypertension, the likelihood being significantly higher among shift workers (32.8% versus 28.0%; p-value<0.001).

Hypertension was significantly higher among males compared to females [38.1% versus 28.5%, p-value=0.03] regardless of their work shift status. As expected men

working in shifts had significantly higher prevalence of hypertension compared to men who did not work in shifts [42.9% Vs 32.2%, p-value 0.032]. It was also found that Hypertension was more prevalent in the age groups of above 50 years which is 54.1% (49.3% in day time and 57.1% in shift workers) followed by 40-49 years which was 44.0% (35.1% in day time workers and 53.1% in shift workers).

Table-2 shows respondents' characteristics on diet. Consumption patterns of the participants for various food groups were studied using a Food Frequency Questionnaire (FFQ). More than half 581(70.0%) of respondents [233(56.4%) and 348(83.5%) in day-time and shift workers] consumed of three or less meals per day, respectively. About 609(73.4%) of respondents, 322(77.2%) of day time workers and 287(69.5%) of the shift workers, consume vegetables more than once per day. More than half 603(72.7%) of respondents, 272(65.2%) of day time workers and 331(80.1%) of shift workers, claimed that they did consume meat once or

less per week. Likewise about 521(62.8%) of respondents, 247(59.2%) of day time workers and 274(66.3%) of shift workers, claimed that they did not consume fruits once or less per week.

**Table 2.** Characteristics of Diet among day and shift workers in Wonji Shoa sugar factory, Ethiopia, January 2012 (n=830).

Variable	Non-shift workers	Shift workers	Total	P- Value
	n(%)	n(%)	n(%)	
Number of meals per day				
>3 per day	180(43.6)	69(16.5)	249(30.0)	0.001
≤3 per day	233(56.4)	348(83.5)	581(70.0)	
Intake of bread and cereals per day				
More than once	131(31.4)	165(40.0)	296(35.7)	0.013
Once or Less than once	286(68.6)	248(60.0)	534(64.3)	
Intake of vegetable per week				
More than once	322(77.2)	287(69.5)	609(73.4)	0.012
Once or Less than once	95(22.8)	126(30.5)	221(26.6)	
Intake of fruits per week				
More than once	170(40.8)	139(33.7)	309(37.2)	0.041
Once or Less than once	247(59.2)	274(66.3)	521(62.8)	
Intake of meat and egg per week				
More than once	145(34.8)	82(19.9)	227(27.3)	<0.001
Once or Less than once	272(65.2)	331(80.1)	603(72.7)	
Intake of Milk and products per day				
More than once	195(46.8)	123(29.8)	318(38.3)	<0.001
Once or Less than once	222(53.2)	290(70.2)	512(61.7)	
Intake of fat per week				
More than once	215(51.6)	142(34.4)	357(43.0)	<0.001
Once or Less than once	202(48.4)	271(65.6)	473(57.0)	
Intake of sugar per day				
More than once	180(43.2)	269(65.1)	449(54.1)	<0.001
Once or Less than once	237(56.8)	144(34.9)	381(45.9)	

The logistic regression analyses showed that shift work, older age, higher income quintile, and family history of hypertension were found to be independently associated with Hypertension. Shift workers were about 48% more likely to be hypertensive when compared with day time workers [AOR (95% CI) = 1.61 (1.23, 2.37)]. Participants at age groups of 40-49 years and above 50 were more than three and half times [AOR (95%) =3.77(1.78,7.74) and four times [AOR (95%) =4.07(2.00,9.99)] more likely to be hypertensive when compared with the age groups of 20-29 years respectively.

Regarding the average monthly income, workers who have

higher income quintile were found to be about three times more likely to be hypertensive when compared to workers whose income is in the lower quintile[AOR(95%CI) =3.24(1.78,5.89)]. Participants who were not alcohol drinkers were 37% less likely to be hypertensive when compared to Alcohol drinkers [COR (95%CI)=0.63 (0.45,0.87)].It is also found that study participants who have family history of hypertension were more than two times more likely to be hypertensive when compared with those who do not have family history[AOR(95%)=2.24(1.54,3.26)]. However, no association was seen between hypertension and smoking, educational status, and nutritional.

**Table 3.** Correlates of hypertension among factory workers, in Wonji Shoa sugar factory, Ethiopia, January 2012 (n=830).

Variables	Hypertension		Crude OR	Adjusted OR
	Yes (n, %)	No (n, %)		
Work pattern				
Non-shift	125(30.0)	292(70.0)	1.00	1.00
Shift	177(42.9)	236(57.1)	1.75(1.32,2.33)*	1.61 (1.23,2.37)*
Sex				
Male	259(38.1)	420(61.9)	1.00	1.00
Female	43(28.5)	108(71.5)	0.39(0.28,0.56)*	0.95 (0.61,1.49)
Age of the respondents				
20-29	18(13.6)	114(86.4)	1.00	1.00
30-39	65(26.5)	180(73.5)	2.29(1.29,4.05)*	1.91(1.03,3.77)*
40-49	114(44.0)	145(56.0)	4.98(2.86,8.67)*	3.77(1.78,7.74)*
>50	105(54.1)	89(45.9)	7.47(4.22,13.23)*	4.07(2.00,9.99)**
Educational status				
Elementary(1-8)	131(37.4)	219(62.6)	1.00	1.00
High school (9-12)	90(33.8)	176(66.2)	0.85(0.61,1.19)	0.88(0.59,1.32)

Variables	Hypertension		Crude OR	Adjusted OR
	Yes (n, %)	No (n, %)		
Diploma	66(39.3)	102(60.7)	1.08(0.74,1.57)	1.36(0.83,2.25)
Degree and above	15(32.6)	31(67.4)	0.81(0.42,1.55)	0.66(0.29,1.49)
Average monthly income (in quintile)				
<600 ETB	38(12.6)	134(25.4)	1.00	1.00
600-1040 ETB	45(14.9)	121(22.9)	1.31(0.79,2.16)	1.09(0.64,1.88)
1040-1600 ETB	62(20.5)	102(19.3)	2.14(1.33,3.46)*	1.41(0.81,2.41)
1600-2400 ETB	70(23.2)	104(19.7)	2.37(1.48,3.80)*	1.46(0.84,2.53)
>2400 ETB	87(28.8)	67(12.7)	4.58(2.83,7.41)*	3.24(1.78,5.89)*
Smoking Habit				
Current Smoker	28(34.6)	53(65.4)	1.00	1.00
Non smoker	274(36.6)	475(63.4)	1.09(0.67,1.77)	1.66(0.95,2.89)
Alcohol drinking				
Drinker	84(44.9)	103(55.1)	1.00	1.00
Non drinker	218(33.9)	425(66.1)	0.63(0.45,0.87)*	0.68(0.46,1.02)
Family history of hypertension				
Yes	93(30.8)	87(16.5)	2.26(1.61,3.15)*	2.24(1.54,3.26)*
No	209(69.2)	441(83.5)	1.00	1.00
Intake of bread and cereals/day				
More than once	115(38.1)	181(34.3)	1.00	1.00
Once or less than once	187(61.9)	347(65.7)	0.85(0.63,1.14)	0.94(0.68,1.31)
Intake of vegetables Per day				
More than once	211(69.9)	397(75.2)	1.00	1.00
Once or less than once	91(30.1)	131(24.8)	1.31(0.95,1.79)	1.31(0.92,1.87)
Intake of milk and milk products per week				
More than once	104(34.4)	213(40.3)	1.00	1.00
Once or less than once	198(65.6)	315(59.7)	1.28(0.96,1.73)	1.09(0.78,1.57)

\* = Statistically significant

## 4. Discussion

Little information exists concerning the prevalence and epidemiological characteristics of hypertension in sub-Saharan Africa particularly on the risk of hypertension in shift workers [29]. While there is growing evidence on the prevalence of the hypertension and associated factors among Ethiopians [19–20]. Our findings of high prevalence of hypertension and its components are in part due to the epidemiological and nutritional transition that has occurred globally including in sub-Saharan African countries where lifestyle and behavioral changes, both products of modernization and urbanization, have taken place [23, 26].

Findings from this study showed a significantly higher prevalence of hypertension among shift workers compared to their counterparts who do not work on shifts. This pattern is consistent with a similar previous study among shift workers in Malaysia although we found a much higher prevalence of hypertension [13] which might be due to the fact that the Malaysian study excluded known hypertensive and diabetic patients. But, contrary to findings of another study in Brazil among the nurses which showed no significant association between shift work and hypertension [10]. This might be their study did not evaluate the duration of shift work. These biases may have led to underestimation of the association between shift work and hypertension.

An increased susceptibility of shift workers to develop chronic diseases such as hypertension can be explained by the disruption of circadian rhythms, and stress related to changes in normal metabolic functions. There is also some evidence that shift work could be associated with unhealthy

behaviors including increase in smoking, drinking alcohol, poor diet, and decrease in physical activity [6,13]. In agreement with previous literature [14, 15], the current study has shown that the proportion of smokers and drinkers is significantly higher among shift workers.

Our study has several strengths; first, it used comparative design which allowed more precise estimate and analysis of factors that might influence the risk of hypertension among shift and non-shift workers. Second, it used standard and calibrated instruments to do the measurements in anthropometry and blood pressure with regular checks on the reliability of measurement tools. It is also possible that study participant's under-report socially undesirable behaviors such as smoking, and alcohol drinking [27]; however, it is very likely that this will be similar among shift and non-shift workers. Although it is limited to employees of one factory, the factory has a relatively huge and stable workforce which added to the diversity in terms of socio-demographic structure of respondents and time of exposure and a significant variability in the burden of hypertension and associated factors in a work environment.

In conclusion, shift work, older age, higher income quintile, and family history of hypertension were found to be independently associated with Hypertension. The finding calls for institutionalization of efficient health screening and regular checkups as well as interventions promoting healthy lifestyles among shift workers.

## Authors' Contributions

HA conceived the idea, designed the study, performed statistical analysis and wrote the manuscript. SS participated

in designing the study, analysis, reviewing and editing the final draft and manuscript. EM participated in reviewing and editing the final draft and manuscript. All authors have approved the final form of the manuscript.

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