Prevalence of hypertension among professional drivers: Evidence from 2000 to 2017—A systematic review and meta-analysis

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ABSTRACT
Background: Hypertension is one of the leading causes of premature deaths worldwide. Drivers have an additional risk of hypertension when compared to the general population because of the nature of their profession. Hence, the current review was done to estimate the global burden of hypertension among professional drivers. Methods: We conducted a systematic search for articles on the prevalence of hypertension among drivers published from 2000 to 2017 in Medline and Embase. Meta-analysis was performed using the random-effects model and pooled prevalence of hypertension was reported. Heterogeneity was assessed using the likelihood ratio (LR) test and publication bias was assessed using Egger’s test. Results: In total, 26 studies with 15,702 drivers were included. The pooled prevalence of hypertension among the drivers worldwide was 34% (95% confidence interval [CI]: 27–40%). World Health Organization (WHO) region-wise estimates showed that prevalence was highest among the drivers in the Western Pacific region (56%) and lowest in the Eastern Mediterranean and African region (21%). Studies showed significant evidence of heterogeneity ($X^2 = 1816.1, P < 0.001$) but there was no significant publication bias ($P = 0.967$). Conclusion: More than one-third of drivers have hypertension globally which is in excess of the general population. Hence, more focus needs to be given for allocating resources and developing workplace interventions for prevention and control of hypertension.

KEY WORDS: Epidemiology, hypertension, meta-analysis, occupations

Introduction
Non-communicable diseases especially cardiovascular diseases have emerged as the number one cause of death worldwide. Morbidity, mortality, and disability attributable to the major non-communicable diseases account for almost 60% of all deaths and 47% of the global burden of disease. It can be caused by a variety of cardiovascular risk factors such as unhealthy diet, physical inactivity, tobacco use, harmful use of alcohol, obesity, diabetes, hypertension (HTN), and dyslipidemia.

HTN is one of the important modifiable risk factors as it has no obvious signs or symptoms making the persons unaware of the condition. World Health Organization (WHO) has rated HTN as one of the leading causes of premature deaths worldwide. Hence, an earlier diagnosis by regular screening and adequate treatment with lifestyle modification and drugs is required for effective reduction in high blood pressure-related morbidity and mortality. However, the proportion of HTN can be excess in certain occupational groups.

The health of occupational workers has several determinants at the workplace leading to accidents, communicable and non-communicable diseases, and stress-related states. Professional drivers are one such group who have a tendency to develop the abovementioned conditions as they spend most of their time at the wheel.
their time in polluted, noisy, and stressful environments. The driving profession itself is stressful because of the pressure to stay on schedule and work for long hours.[9] They spend most of their time in traffic and also are exposed to unhealthy lifestyles such as irregularities of meals and sleep patterns, low-intensity physical activity, smoking and tobacco consumption leading to a higher prevalence of HTN when compared to the general population.[7-9]

Studies around the world have also reported the prevalence of HTN to be significantly higher than the general population.[9-11] However, most of the studies were conducted within the smaller geographical region or reported within-country estimates. We could not find any region-wise or global estimates for the prevalence of HTN among professional drivers. It is essential to have these estimates as it will give evidence whether the prevalence is higher when compared to the general population and help in taking measures or develop appropriate strategies for prevention and control of HTN among drivers. Hence, we conducted the current systematic review and meta-analysis to find the global and WHO region-wise prevalence estimates of HTN among professional drivers.

METHODS

Inclusion criteria for studies considered for the review

Type of studies
We included studies reporting the prevalence of HTN among professional drivers for the current review. There was no restriction related to study design, geographic region, or age groups. We included the studies irrespective of the setting in which the study was conducted (community or workplace-based). Studies reported as the full text was included while studies published with only abstract or unpublished data were excluded.

Type of participants
The study was conducted among 18-year-old adults who were working as drivers irrespective of the place of occupation (either government or private) and vehicle (bus, truck, or taxi).

Type of outcome measure
Studies reporting the prevalence of HTN and diagnosing it as per the Joint National Committee (JNC) criteria[12] (systolic blood pressure = ≥140 mm Hg (AND/OR) diastolic blood pressure = ≥ 90 mm Hg) were included to obtain the pooled prevalence estimate for HTN among professional drivers.

Search strategy
Two authors (YK, GS) independently performed a systematic literature search in Medline and Embase between February and April 2018. A combination of medical subject heading (MeSH) and free-text terms was used for carrying out the literature search. The following MeSH terms were used in PubMed search engine in various combinations: “Prevalence,” “Incidence,” “Epidemiology,” “Hypertension,” “Blood Pressure,” “Drivers,” “Bus Drivers,” and “Truck Drivers.” The search strategy used in PubMed is provided in the supplementary file. The search was restricted to English language publications between the years 2000 and 2017. Similar terms were used in Embase for literature search of published studies. Additional search attempts were made using the bibliographies of the included studies.

Selection of studies
Step 1: Identification and retrieval of studies based on relevance: Initially, the screening of title and abstract was done independently by two authors (YK, GS) to find out articles relevant to the current review. Full-text articles were obtained for those studies that were found to be relevant.

Step 2: Screening of retrieved studies for eligibility criteria: Further screening of abstract and full text of the retrieved articles was done independently by the primary and secondary author (YK, GS) to select the studies that satisfy the eligibility criteria of the current review.

Step 3: Quality check: Quality of the overall review process was monitored by the third author (MS). Criteria for the definition of HTN were cross-checked by the first and second authors (YK, GS). Any disagreements during the entire selection process between two authors were resolved either through consensus or consultation with the third author (MS).

Data extraction and management
A predesigned data collection pro forma was used by the first and second authors (YK, GS) to extract relevant data from the included studies. The details included in the data collection form were publication year, study design, author name, study setting, study population, sample size, and information on an outcome such as prevalence or estimates of HTN. In addition, the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) checklist was used for the reporting of the current review.[13]

Risk of bias assessment in included studies
Two independent authors (YK and GS) assessed the quality of all the included studies using the Newcastle-Ottawa (NO) scale adapted for cross-sectional studies. Three criteria (selection, comparability, and outcome) are used to assess the quality of evidence on the NO scale. Since this review does not include the comparability domain, only section and outcome-related criteria were used. The following criteria were used for assessing the risk of bias under selection domain: representativeness of the sample, sample size, nonrespondents, and assessment of exposure. Under the outcome domain, the assessment of the outcome and statistical test were used to assess the risk of bias. Each of these six criteria will be rated as either high (0 points) or low risk of bias (1 point) based on the quality of evidence. Studies with less than 4 points were considered to have a high risk of bias.

Statistical analysis
Meta-analysis was performed with the selected studies using STATA 12 (StataCorp, College Station, TX, USA). For each of the studies, the standard error was calculated using the reported prevalence of HTN and the total sample size. “Metaprop” function was used for the analysis of the current review.[14] We applied the random-effects model as there is a difference in the
Likelihood ratio (LR) tests were performed for the assessment of heterogeneity. Since there was significant heterogeneity among the studies included in the analysis ($P < 0.05$), we performed additional subgroup analysis and meta-regression to explore the potential sources of heterogeneity. Subgroup analysis was performed based on WHO regions (Southeast Asia, Africa, the Americas, Europe, the Eastern Mediterranean, and Western Pacific). Potential covariates for meta-regression were study regions, publication year, type of driver, sample size, and quality of studies included. We performed multivariable meta-regression analysis by including the study level factors with a $P$ value of less than 0.2 in the univariate model. Study-specific prevalence estimates and pooled estimates were graphically represented through forest plot for both combined and region-wise analysis. Publication bias was assessed using Egger’s test and graphically represented by the funnel plot.[15]

Results

Study selection

Overall 1889 citations were identified, of which 1393 were from Medline and 496 from Embase. 934 references were identified after the application of certain filters. After the removal of duplicates and studies not meeting the eligibility criteria, we ended up with 26 studies as depicted in Figure 1. The reasons for exclusions were studies not pertaining to HTN ($n = 181$), studies not pertaining to drivers ($n = 233$), duplicates ($n = 68$), and objectives and results did not match the review criteria. Finally, 20 articles were included for meta-analysis.

Figure 1: Flowchart showing the selection of studies for the meta-analysis on the prevalence of hypertension among professional drivers (2000–2017)
criteria \((n = 114)\). Finally, we analyzed data from 26 studies with 15,702 participants satisfying the inclusion criteria.\cite{15,16,17}

Characteristics of the included studies

Table 1 lists the characteristics of the studies analyzed. All the included studies were cross-sectional studies. Majority of the studies (8 out of 26) were conducted in Southeast Asian region (SEARO) followed by American region (6 out of 26), African region (AFRO) (4 out of 26), European region (EURO) (3 out of 26), Western Pacific Region (WPRO) (3 out of 26), and Eastern Mediterranean region (EMRO) (2 out of 26). 11 out of 26 studies were conducted exclusively to determine the prevalence of HTN while the rest of the studies were done for the assessment of cardiovascular risk factors from which HTN prevalence was noted. The majority of the studies were conducted among bus drivers (16 out of 26) followed by truck drivers (7 out of 26). A sample size of the included studies ranged from 120 to 3376.

Methodological quality of the included studies

We performed assessments of risk of bias for all the included studies and reported in Table 2. The majority of the studies (15 out of 26) had a low risk of bias with respect to representativeness of the sample as they have done random sampling or included all the eligible drivers into the study. Only four studies have reported and justified the sample size taken for their studies. The majority (16 out of 26) of the studies had a low risk of bias with respect to the use of validated measurement tools while the rest of the studies did not report on the measurement tool. Only two studies did not report on the measurement of outcome (whether independent blind assessment or record linkage was done). Six studies did not

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**Table 1: Characteristics of the studies included in the review \((n=26)\)**

| Study | Study setting | Study population | No. with hypertension/total sample size | Prevalence, % (95% CI) |
|-------|---------------|------------------|----------------------------------------|------------------------|
| Overall |               |                  |                                        | 34 (27-40)             |
| Western Pacific Region (WPRO) |               |                  |                                        | 56 (55-58)             |
| Wang, 2001 | Taipei, Taiwan | Bus drivers | 986/1761 | 56 (54-58) |
| Siu, 2012 | Hong Kong | Professional drivers | 1924/3376 | 57 (55-59) |
| Shin, 2013 | Korea | Bus drivers | 236/443 | 53 (49-58) |
| Pan American Health Organization (PAHO) |               |                  |                                        | 32 (24-42)             |
| Filho HR, 2002 | Campinas, Brazil | Bus drivers | 9/108 | 13 (07-21) |
| Cavagioni, 2010 | Sao Paulo, Brazil | Truck drivers | 96/258 | 37 (31-43) |
| Hirata, 2012 | Parana, Brazil | Bus drivers | 252/459 | 38 (35-42) |
| Sangaleti, 2014 | Parana, Brazil | Truck drivers | 113/250 | 45 (39-52) |
| Mansur, 2015 | Sao Paulo, Brazil | Truck drivers | 577/2228 | 26 (24-28) |
| Reis, 2017 | Goias, Brazil | Truck drivers | 61/155 | 39 (32-48) |
| African Region (AFRO) |               |                  |                                        | 21 (12-32)             |
| Amira, 2006 | Lagos, Nigeria | Bus drivers | 36/194 | 19 (13-25) |
| Erhiano, 2015 | Sokoto, Nigeria | Bus drivers | 73/218 | 33 (27-40) |
| Oyeniyi, 2016 | Abuja, Nigeria | Professional drivers | 37/398 | 9 (7-13) |
| Odeyinka, 2017 | Ibadan, Nigeria | Bus drivers | 84/305 | 28 (23-33) |
| European Region (EURO) |               |                  |                                        | 51 (32-70)             |
| Persu, 2006 | Belgium | Taxi drivers | 43/103 | 42 (32-52) |
| Marcinkiewicz, 2010 | Poland | Bus and truck drivers | 209/570 | 37 (33-41) |
| Platek, 2017 | Poland | Professional drivers | 104/141 | 74 (66-81) |
| Eastern Mediterranean Region (EMRO) |               |                  |                                        | 21 (20-23)             |
| Saberi, 2011 | Kashan, Iran | Bus and truck drivers | 184/429 | 43 (38-48) |
| Izadi, 2013 | Tehran, Iran | Professional drivers | 312/1903 | 16 (15-18) |
| Southeast Asian Region (SEARO) |               |                  |                                        | 30 (22-39)             |
| Satheesh, 2013 | Karnataka, India | Bus drivers | 80/500 | 16 (13-20) |
| Lakshman, 2014 | Kerala, India | Bus drivers | 74/179 | 41 (34-49) |
| Priya, 2015 | Karnataka, India | Bus drivers | 70/200 | 35 (28-42) |
| Udayar, 2015 | Andhra Pradesh, India | Bus drivers | 29/204 | 14 (10-20) |
| Udayar, 2015 | Andhra Pradesh, India | Bus drivers | 34/244 | 14 (10-19) |
| Borle, 2015 | Maharashra, India | Bus drivers | 202/581 | 35 (31-39) |
| Chankaramangalam, 2017 | Tamil Nadu, India | Truck drivers | 70/175 | 40 (33-38) |
| Jayarajah, 2017 | Colombo, Sri Lanka | Bus drivers | 44/120 | 37 (28-46) |
report on the statistical tests performed in their studies. Only three studies have reported on nonresponse rates with their characteristics. Overall, seven studies had a high risk of bias with a score of 4 or more on the NO scale.

**Hypertension burden among drivers**
The pooled prevalence estimate of HTN with 95% CI calculated as depicted in Figure 2. The pooled estimate was calculated after adjusting for population size weights. The overall prevalence of HTN among the drivers around the world during the 18-year period was 34% (95% CI: 27–40%). We found significant heterogeneity among the studies reporting the prevalence of HTN among professional drivers ($\chi^2 = 1816.1, P < 0.001$).

**Subgroup analysis**

**Western Pacific Region**
Prevalence estimates of HTN were reported in three studies in the WPRO region. The pooled region-wide prevalence of HTN among drivers in WPRO was 56% (95% CI: 55–58%). WPRO had the highest prevalence estimate of HTN in drivers when compared to all other WHO region-specific estimates as depicted in Figure 3. We did not find significant heterogeneity among studies reporting the prevalence of HTN in the WPRO region.

**American region**
In total, six studies reported prevalence estimates of HTN among drivers in the American region. The overall region-wide prevalence estimate of HTN among drivers in the Pan American Health Organization (PAHO) over the 18-year period was 32% (95% CI: 24–42%). This estimate was slightly lesser than the overall pooled estimate of HTN in drivers. There was significant heterogeneity among the studies reporting HTN prevalence among drivers in the PAHO region ($\chi^2 = 69.48, P < 0.001$).

**Africa region**
Four studies from the AFRO region were included for subgroup analysis. The pooled prevalence of HTN among drivers in the AFRO region was 21% (95% CI: 12–32%). AFRO region reported the lowest prevalence of HTN in drivers along with EMRO. We did not find significant heterogeneity among studies reporting the prevalence of HTN in AFRO.

**Europe region**
In total, three studies reporting the prevalence estimate were included for the region-wise analysis. The pooled estimate of the prevalence of HTN among drivers in EURO was 51% (95% CI: 32–70%). We did not find significant heterogeneity among studies reporting the prevalence of HTN in EURO.
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Eastern Mediterranean region (EMRO)
The fixed-effects model was applied for the EMRO studies as there was no heterogeneity among the study estimates. However, only two studies were included as they reported the prevalence estimates. EMRO reported the lower prevalence (along with AFRO) of HTN in drivers. The pooled prevalence estimate was 21% (95% CI: 20–23%). We did not find significant heterogeneity among studies reporting the prevalence of HTN in the EMRO region.

Southeast Asian region (SEARO)
A maximum number of studies reporting prevalence estimates of HTN in drivers was from SEARO (n = 8) especially from India. The random-effects model was applied for the calculation of pooled estimates as there was significant heterogeneity between the study estimates ($\chi^2 = 110.056, P < 0.001$). The pooled prevalence of HTN in drivers from SEARO was 30% (95% CI: 22–39%).

Meta-regression
First, we conducted univariate meta-regression with individual study level factors such as publication year, sample size, study region, type of drivers, and risk of bias indicators (representativeness of the sample, sample size justification, validated tool, independent measurement of outcome, reporting of nonresponse rate and statistical tests). We did not find a significant association with any of the abovementioned covariates. However, we performed multivariable meta-regression with factors having a $P$ value less than 0.2 such as sample size, study region, type of drivers, validated tool, independent measurement of outcome, and reporting of nonresponse rate. The adjusted model was able to explain 31.8% of the between-study variability and the model was statistically significant ($P = 0.05$).

Publication bias
Egger’s test was applied for the assessment of publication bias. There were no small study effects with nonsignificant coefficient value (coefficient: 0.163; 95% CI: -8.03 to 8.36; $P = 0.967$) which shows the lack of evidence of publication bias. Graphical representation of the test of publication bias was depicted through the funnel plot in Figure 4. The funnel plot also showed a symmetric plot indicating the absence of publication bias.

Discussion
We have conducted this review to obtain a comprehensive estimate of the burden of HTN among drivers around the world. We have also captured the WHO region-wise estimates to find any significant difference in the estimates of HTN between the regions and report a final representative estimate. In total, 26 studies around the world with 15,702 participants reporting the prevalence estimates of HTN among drivers and
Figure 3: WHO region-specific prevalence of hypertension among professional drivers (2000–2017)

Figure 4: Funnel plot of publication bias in the meta-analysis studies (n = 26) on the prevalence of hypertension among professional drivers

published over a period of 2000 to 2017 were included. Most of the studies were conducted in low and middle-income countries in the SEARO region like India. The majority of the included studies (19 out of 26) had a low risk of bias. We found significant heterogeneity among the included studies. Hence, we performed additional subgroup analysis and meta-regression and found that study region, sample size, type of vehicle driven, reporting of a validated tool, independent measurement, and nonresponse rate as potential sources of heterogeneity in our review. We also found a symmetrical funnel plot indicating an absence of publication bias.

A meta-analysis of the included studies showed that the global prevalence of HTN among professional drivers as 34% (95% CI: 27–40%). WHO Global Health Observatory in 2015 has reported the prevalence of raised blood pressure among the general population as 22.1%. This proportion is relatively lower when compared to the findings in the meta-analysis. Hence, the current review shows that the burden of HTN is excess among the drivers when compared to the general adult population. However, further studies or reviews on factors responsible for this disparity need to be done which will help in developing targeted intervention or health policies.
WHO region-wise estimates were obtained for the following six regions: Asia, Africa, Europe, America, Western Pacific, and Eastern Mediterranean. We have found a considerable geographical variation in the burden of HTN among drivers. The prevalence was highest among the drivers in WPRO (56%) and lowest among the drivers in EMRO and AFRO (21%). Possible causes of variation in blood pressure across these regions could be the differing work schedule such as duration of work hours, night shifts, the pressure to keep on schedule as each region has its own guidelines related to public transport. Another reason could be the level of traffic congestion and availability of facilities like a canteen with healthy food options, a suitable environment to do physical activity (as drivers spend most of their day sitting in one place).

These region-wise estimates were different in the general population. WHO reported that Africa (27.4%) and EMRO (26.3%) have the highest burden of raised blood pressure among the general population, while higher-income regions such as Americas (17.6%) and WPRO (19.2%) has the least prevalence.\(^{(39)}\) This contrast finding drivers when compared to the general population may be due to the difference in socioeconomic and cultural characteristics, work-related stress, workload, traffic, and pollution burden in each specific region. These factors need to be explored individually to explain the considerable region-wise difference between the drivers and the general population. Further alternate approach studies using the Bayesian or hierarchical modeling technique can be done to explore and discriminate the region-wise findings reported in the current review.

The major strength of the study is that we have tried to provide the first comprehensive review on the global burden of HTN among professional drivers and specific for each of the WHO regions. Even though many reviews have been conducted to determine the global burden of HTN, we could not find any review specific for drivers neither globally nor region wise. Test for publication bias has found that there was no significant bias in the current review.

However, our review has certain limitations. First, summarizing and concluding the burden as 34% among drivers in the world with demographic, socioeconomic, and occupational differences is difficult because of the inherent heterogeneity. We have tried to overcome this limitation by conducting subgroup analysis based on WHO regions and provided individual prevalence estimates. However, the differences that exist region-wise can have an effect on the estimates. The LR test for heterogeneity also revealed significant variability across the global and region-wise-included studies. Hence, we tried to explain the between-study variability using meta-regression and found the potential sources of heterogeneity. Second, we have accessed only Medline and Embase for the retrieval of studies in the current review.

In spite of these limitations, the current review provides important baseline information on the burden of HTN among professional drivers worldwide. The higher prevalence among drivers when compared to the general population can be attributed to the unhealthy and stressful life led by them. We have found that there is an increasing trend in the number of studies done on HTN among drivers over the past 7 years. There were a total of 20 published studies between the years 2011–2017 when compared to six published studies during the years 2000–2010 as reported in the current review. This shows the recent interest developed among the medical community and researchers toward this public health problem. However, there was a lack of studies on the determining factors, awareness, and control status of HTN among the bus drivers as it will help in finding the gap between the reach of services to drivers when compared to the general population.

More such comprehensive pieces of evidence need to be generated by each of the countries especially among the regions with the highest prevalence such as Western Pacific to know about the extent of the problem and inform the relevant policymakers. This will stimulate the government to allocate adequate resources and establish appropriate interventional strategies. One important measure that needs strict implementation throughout the world is a preplacement screening of blood pressure for HTN. Persons identified with raised blood pressure can be suggested to take up any other less stressful job as suggested by the concept of “Ergonomics” (fitting the job to the worker).\(^{(40)}\) After recruitment, further periodic screening needs to be done at least every year.

Further workplace interventions that can be taken for prevention and control of HTN are conducting regular health education sessions on how to prevent the HTN by lifestyle modifications such as healthy dietary habits and adequate physical activity or maintaining the control status of persons with HTN by proper adherence to medications and annual visit by mental health counselors for counseling of persons with high degree of stress. The development and implementation of protocols and guidelines for the screening and management of HTN for vulnerable occupational groups can be done at the national level. Incorporation of multiple components at multiple levels can be done in existing interventions to achieve better control of HTN among the bus drivers worldwide.

**Conclusion**

To conclude, our review has found that more than one-third of drivers have HTN globally which is in excess of the general population. Region-wise estimates showed that drivers in WPRO had the highest prevalence and drivers in AFRO and EMRO had the lowest prevalence. Hence, further evidence needs to be generated for each of the countries especially the region with higher prevalence to identify the magnitude of the problem and factors responsible for it which will help in developing appropriate health education and health promotion strategies for prevention and control of HTN.

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Conflicts of interest
There are no conflicts of interest.

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