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The influence of shift work on cardiovascular disease risk in Southern African long-distance truck drivers: A cross-sectional study

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Abstract

Objectives:

Cardiovascular disease (CVD) is a major problem globally. Truck drivers have an increased risk of CVD due to a sedentary lifestyle, irregular working hours and behavioral choices. We aimed to get insight into the contribution of night shift work to CVD risk in long-distance truck drivers in South Africa.

Design:

A cross-sectional study was performed.

Setting:

Enrollment took place at three South African truck stop locations in two provinces; Bloemfontein (Free State), Pomona Road (Gauteng), and Soweto (Gauteng).

Participants:

607 males aged 18 years and older with full-time employment as a long-distance truck driver were included. The criteria for inclusion were willingness and being able to provide informed consent and to complete the study procedures.

Primary and secondary outcome measures:

Information was collected on socio-demographics, occupational and health characteristics. Besides, physical measurements, an electrocardiogram (ECG), and carotid intima-media thickness (CIMT) measurements were taken. A night shift was defined as working between 10pm and 6am. CVD risk was defined with the Framingham Risk Score (FRS), the Atherosclerotic Cardiovascular Disease (ASCVD) risk algorithm, left ventricular hypertrophy (LVH), and CIMT.

Results:

In total, 607 truck drivers were included, of which 305 (50.2%) worked in day shifts only and 302 (49.8%) worked day and night shifts. There was a high prevalence of CVD risk factors in both groups as 33% were hypertensive, 28% obese and 37% had abnormal

lipid levels. Working day and night shifts compared to working only day shifts did not result in differences in FRS, ASCVD risk, or LVH. No difference was found in CIMT measurements, except for the maximum bulb thickness which was higher in day shift workers.

Conclusions:

CVD risk factors are considerably present in male truck drivers in South Africa. CVD risk does not differ between dayshift and day-night shift workers in this cross-sectional analysis.

Article summary

Strengths and limitations of this study

- With 607 included participants this is the largest cohort of male truck drivers in South Africa and to our knowledge possibly the largest in Africa.
- We collected a wide variation of characteristics combined with physical measurements, ECG and carotid measurements.
- We defined our outcome of cardiovascular disease risk in multiple ways, making our outcomes more reliable.
- The definition of night shift work is varying throughout literature, to account for this we did additional sensitivity analyses using different cut-offs for the number of nights.

Study approval

The study was approved by the Human Research Ethics Committee (Medical) of the University of Witwatersrand (reference number M160760).

Introduction

Cardiovascular disease (CVD) is the number one cause of death and a leading cause of disability globally. An estimated 17.9 million people died of CVD in 2016, 31% of all global deaths[1,2]. Over 75% of CVD events occur in low- and middle-income countries[3]. In South Africa, CVD is responsible for approximately 20% of all deaths, making it is the second leading cause of death after HIV[4,5]. The cause of CVD is multifactorial and includes behavioral factors such as smoking, physical inactivity, unhealthy dietary patterns and lifestyle related conditions such as high cholesterol, high blood pressure, and high body mass index[6].

Truck drivers are a high risk population for CVD by virtue of their occupation with long working hours, frequent shift work and low physical activity. There is a high prevalence of risk factors contributing to CVD in truck drivers in South Africa such as smoking, obesity, hypercholesterolemia, hypertension, and abnormal glucose levels[7,8].

Irregular working hours and night shifts are risk factors for CVD; exposure to shift work for 5 years has been associated with a 7% increased CVD risk[9]. A possible reason for the increase in CVD risk may be circadian misalignment. Circadian misalignment reflects a non-optimal scheduling of behavioral and environmental cycles such as sleep/wake, fasting/feeding, rest/activity, dark/light cycles, with respect to endogenous biological processes governed by the circadian system, such as blood pressure, hormones, and inflammation factors[10].

This study aims to gain insight into the contribution of night shift work to CVD risk in long-distance truck drivers in South Africa by comparing truck drivers who work day shifts only to truck drivers who work day and night shifts.

Methods

Study design and setting

The Trucker Health Survey was an initiative of the Wits Reproductive Health and HIV Institute (Wits RHI), a department of the University of the Witwatersrand, and North-Star Alliance (NSA). NSA provided health care services to truck drivers[11]. Methods and characteristics of the study have been described previously[12]. Enrollment took place between October 2016 and March 2017 in three South African locations in two provinces; Bloemfontein (Free State), Pomona Road (Gauteng), and Soweto (Gauteng). The truck stop in Soweto was added from January to March 2017 to reach a sufficient number of South African participants. Information was collected during a single visit.

The study was approved by the Research Ethics Committee of the University of the Witwatersrand (reference number M160760). Participation was voluntary, and informed consent was obtained by a research nurse or counselor who spoke the same language as the participant.

Study population and inclusion criteria

Males aged 18 years and older with full-time employment as a long-distance truck driver were included. The criteria for inclusion were willingness and being able to provide informed consent and to complete the study procedures. All participants with data on shift work available were eligible for this analysis.

Patient and Public involvement statement

Patients and the public were not involved in the study design, or in the recruitment to, and conduct of the study. Results cannot be disseminated to study participants directly due to insufficient contact information.

Evaluation

Information on socio-demographic (i.e., age, education, country of origin, marital status), occupational (i.e., time spent working, working night shifts) and behavioral/health (i.e. smoking status, physical activity, sleep duration per day, HIV status) characteristics were collected using validated questionnaires[13–16]. The main definition for night shifts was working at least three hours once a week between 10pm and 6am, the remaining was defined as dayshift workers. Night shift truck drivers worked either one night shift a week, two to three night shift a week or more than four night shifts a week. We used those different cut-offs in a sensitivity analysis to investigate whether an increased number of nights shifts would be associated with increased CVD risk.

CVD risk was defined with four different outcome measures namely the Framingham Risk Score (FRS), the Atherosclerotic Cardiovascular Disease (ASCVD) risk algorithm, left ventricular hypertrophy (LVH) on electrocardiogram (ECG) and carotid intima-media thickness (CIMT).

Physical measurements included measurement of blood pressure, waist and hip circumference, height and weight. Blood was collected for measurement of total cholesterol, high-density-lipoprotein (HDL) cholesterol, low-density-lipoprotein (LDL) cholesterol, triglycerides (TG), random glucose and creatinine. Blood pressure was categorized as normal, pre-hypertension and hypertension[17]. Cut-off points for glucose and cholesterol were chosen according to international guidelines[18,19]. Estimated glomerular filtration rate (eGFR) was calculated using creatinine levels and presented in stages of chronic kidney disease[20].

CVD risk according to the FRS was calculated for participants without CVD at baseline and categorized in low-, intermediate- and high-CVD risk[21,22]. The ASCVD risk algorithm was calculated for participants between the age of 40 to 70 according to algorithm guidelines[19,23].

A standard 12 lead ECG was performed by a trained nurse with a computer-based ECG device (SE-1515 DP12, EDAN)[24] to record heart rate, rhythm and conduction time. LVH was assessed using Cornell's voltage ($RaVL+SV_3$), Cornell's product (($RaVL+SV_3$) x QRS duration) and Sokolow-Lyon's voltage (SV_1+RV_5). LVH was defined as Cornell's voltage ≥ 28mV, Cornell's product > 2440 mV·ms or Sokolow-Lyon's voltage ≥ 35mV[25–28]. The combined outcome of LVH was deemed positive if one or more criteria indicated LVH.

CIMT was measured in 217 (42.9%) participants, dependent on the availability of a sonographer. A Siemens Acuson p500 ultrasound (Siemens Healthcare (Pty) Ltd, South Africa) with a ≥ 7mHz linear probe was used. Measurements of the near wall and the far wall of the common carotid artery (CCA) were taken at three standardized angles each side using the Meijer's Arc[29]. At bulb level, the far wall was measured at the best visible angle at both sides. The images were analyzed off-line in batch with the semi-automatically Artery Measurement System software (Chalmers University, Götenburg, Sweden). The mean of the mean common carotid artery intima-media thickness (CCA-IMT) and the max of the mean CCA-IMT were calculated by averaging the near and far wall measurements across the three angles on both sides. Mean-max bulb IMT was calculated using bilateral measurements of the bulb far wall. A mean CCA-IMT of > 1.0mm at any of the measured angles was considered a carotid plaque[30,31].

Statistical analysis

Analyses were done using SPSS version 25.0 (SPSS Inc. Chicago, IL, USA). A $p \leq 0.05$ was considered to be statistically significant. Categorical variables were represented as counts with percentages. All continuous outcomes were non-normally distributed and summarized using median with interquartile range (IQR). To test for differences between day and night shift workers a Chi-square test was used for categorical variables and a Mann-Whitney-U test was used for continuous variables. Linear regression for FRS, ASCVD risk and mean CCA-IMT was done after transformation to meet criteria for normal

distribution. Binomial logistic regression was used to assess the influence of night shift work on the occurrence of LVH. Variables considered as confounders for all outcomes were age, country of origin, education level and relationship status. We did not adjust for known CVD risk factors as our outcomes represent the cumulative effect of CVD risk factors. The aim is to investigate CVD risk differences between the groups, and not the contribution of individual CVD risk factors to our endpoints. Variables were included in multivariable analysis if the p-value was ≤ 0.20 in univariable analysis. Age was added to the multivariable model independent of the p-value in univariable analysis.

In a sensitivity analysis, above described analyses were repeated using different cut-off points for night shift work. Finally, all analyses were repeated including only truck drivers who had been working as a truck driver for more than 10 years (n = 229 out of 607).

Results

In total, 607 (99%) male truck drivers had data on shift work available and were included, of which 305 (50.2%) worked in day shifts only and 302 (49.8%) worked both day and night shifts (Table 1).

There were no drivers who only worked night shifts. The median age was 37 (IQR: 31-42) years. The majority of the drivers were from Zimbabwe (62.5%), followed by South Africa (20.2%). The drivers had worked for a median duration of 9 (IQR: 5-14) years as a truck driver. There was a high prevalence of CVD risk factors in both groups as 28% of participants were obese, 33% hypertensive and >35% had abnormal LDL and TG levels. No significant differences were seen between the groups for most of the CVD risk factors. The day-night shift group had a higher activity score ($p = 0.02$), higher neck circumference ($p < 0.01$) and a lower waist to hip ratio ($p = 0.03$) than the participants who worked day shifts only.

Shift work was borderline associated with a difference in FRS (p = 0.05) as continuous outcome, but there was no difference between the groups when categorized in low, intermediate and high risk (p = 0.57).

Shift work was not associated with ASCVD risk score (p = 0.94), LVH occurrence (all p > 0.20) or CIMT, except for max bulb IMT, which was higher in day shift workers compared to day-night shift workers (p < 0.01) (Table 2).

Factors associated with higher FRS and ASCVD in multivariable analysis were increasing age (p < 0.01 for both), having finished primary school or less (p = 0.01 and p < 0.01 respectively), and a stable relationship (p < 0.01 for both). An increase in age (p < 0.01) was associated with an increase in mean CCA-IMT. A stable relationship was positively associated with LVH (p < 0.01) (Appendix 1).

Repeating the analysis using different cut-offs for night shift work resulted in the same findings. Limiting the analysis to truck drivers who had been working as a truck driver for more than 10 years (n=229) did also not show a difference in CVD outcomes between day and day/night shift workers.

Discussion

Our study provides insight into the role of shift work on CVD risk in truck drivers in South Africa and possibly sub-Saharan Africa. We did not find an association between shift work and CVD risk according to the FRS strata, the ASCVD risk score, LVH, and CIMT.

Our results are in line with recent studies done in cohorts of hospital workers. A study including female hospital employees showed that shiftwork was not directly linked to CVD risk[32]. Another study on health care workers employed in hospitals found no difference in metabolic risk factors between day and night shift workers[33]. Similar results were seen in a Finnish cohort study with a 20-year follow-up period as no association between shift work and cardiovascular morbidity was observed[34].

However, there are studies, mainly including health care professionals, which did find an increased CVD risk for night shift workers. One study found that shift work for more than five years has a positive and significant dose-response relationship on CVD risk. Shift work less than five years did not have a relation with CVD risk[9]. When we included only drivers who worked in night shifts for more than ten years, we did still not find an association between shift work and CVD risk. A reason might be that hospital workers in general work more hours during a night shift, and hence more circadian misalignment, than long distance truck drivers.

Our findings on the abundance of CVD risk factors are in line with other studies that showed that CVD risk factors are notably present in truck drivers[35,36]. In the South African Demographic and Health Survey including almost 14.000 participants with a mean age of 38.5 years, the overall prevalence of hypertension was 30% and the prevalence of obesity was 20%[37]. In a population study in the northern part of South Africa, including 3641 participants (64% males, median age <30 years) 30% of the men had hypertension, 5% were obese and up to 20% had disturbances in lipid levels[38].

In our population the mean age was 37.6 years. Hypertension occurred in 33% of the participants, and 28% was obese. In our study up to 37% of the participants had abnormal lipid levels. To summarize, it seems that in our study there is a comparable percentage of hypertension, but increased percentage of obesity and abnormal cholesterol levels.

Some limitations need to be mentioned. The first relates to our definition of night shifts, as only 3 hours of work between 10pm and 6am classified someone as a night shift worker. To account for this, we did additional sensitivity analyses using different cut-offs for the number of nights. This did not change our findings. Unfortunately we did not have information on the exact number of hours worked per night as defining a night shift based on hours worked per night instead of defining a night shift as soon as one has worked 3 hours between 10pm and 6 am might have influenced our findings.

The combined LVH outcome may result in overestimating the number of participants with LVH as the gold standard to evaluate LVH would be cardiac echocardiography. CIMT data were only available for 43% of the participants. This limits the power, but as CIMT scans were omitted randomly and the number of missing scans was evenly divided over the groups, we do not expect that this would result in a bias.

A major strength of this study is the size of the study with 607 truck drivers, of whom half were working day-night shifts. This is the largest cohort of male truck drivers in South Africa and to our knowledge possibly the largest in Africa. Our data represent the situation in the general truck driver community in South Africa and beyond as drivers from several African countries were included at public truck stops. Another strength is that we defined CVD risk in different ways, and we have shown that outcomes do not differ significantly between day- and day-night shift workers.

Conclusion

CVD risk factors are abundantly present in male long-haul truck drivers in South Africa. CVD risk does not differ between dayshift and day-night shift workers in this cross-sectional analysis. Nevertheless, the high prevalence of CVD risk factors in this male cohort necessitates further investigation to develop and implement strategies to reduce CVD risk.

Author contributions

Designed the study: MD, AGV, WDFV, DEG. Analysed the data and interpreted results: MD, KS, AGV. Wrote the initial draft: MD, AGV. All authors critically reviewed and approved of the final draft.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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The views of this study are those of the authors and do not necessarily reflect the views of any of the funders or the South African and Dutch governments.

Data availability statement

Deidentified participant data are available upon reasonable request by contacting the corresponding author.

Study approval

The study was approved by the Human Research Ethics Committee (Medical) of the University of Witwatersrand (reference number M160760).

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Table 1. Characteristics of the study population

	Participants (n=607)	Day shifts (n=305)	Day-night shifts (n=302)
Age (years), median (IQR)	37 (31-42)	37 (32-43)	36 (30-42)
Country of origin, n	605	303	302
Zimbabwe, n (%)	378 (62.5%)	188 (62.0%)	190 (62.9%)
South Africa, n (%)	122 (20.2%)	60 (19.8%)	62 (20.5%)
Zambia, n (%)	45 (7.4%)	24 (7.9%)	21 (7.0%)
Other, n (%)	60 (9.9%)	31 (10.2%)	29 (9.6%)
Working as driver (years), median (IQR)	9 (5-14)	9 (5-14)	8 (5-14)
Time spent working per month (days), median (IQR)	20 (15-24)	20 (18-24)	20 (15-24)
Time sleeping/day (hours), median (IQR)	8 (6-9)	8 (6-9)	7.5 (6-9)
Education level, n	585	287	298
Primary school or less, n (%)	51 (8.7%)	32 (11.1%)	19 (6.4%)
Secondary school, n (%)	322 (55.0%)	150 (52.3%)	172 (57.7%)
Matrix/college/university, n (%)	212 (36.2%)	105 (36.6%)	107 (35.9%)
Marital status, n	607	305	302
Stable relationship, n (%)	545 (89.8%)	278 (91.1%)	267 (88.4%)
No relationship, n (%)	62 (10.2%)	27 (8.9%)	35 (11.6%)
HIV positive, n (%)	54 (8.9%)	24 (7.9%)	30 (9.9%)
Weekly leisure activity score, median (IQR)	17 (0-27)	17 (0-19)	17 (0-31)
Body mass index (kg/cm^2), n	597	298	299
Body mass index < 30 kg/cm^2, n (%)	428 (71.7%)	220 (73.8%)	208 (69.6%)

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Body mass index ≥ 30 kg/cm^2, n (%)	169 (28.3%)	78 (26.2%)	91 (30.4%)
Waist to hip ratio, median (IQR)	0.86 (0.81-0.91)	0.87 (0.82-0.92)	0.85 (0.80-0.91)
Neck circumference (cm), median (IQR)	37 (36-39)	37 (35-39)	38 (36-40)
Smoking ever in life, n (%)	90 (14.9%)	47 (15.6%)	43 (14.2%)
Family history for CVD, n (%)	32 (5.3%)	14 (4.7%)	18 (6.0%)
Heart rate (bpm), median (IQR)	75 (66-83)	75 (68-83)	75 (65-83)
Blood pressure classification, n	594	297	297
Normal, n (%)	100 (16.8%)	43 (14.5%)	57 (19.2%)
Pre-hypertension[a], n (%)	297 (50.0%)	159 (53.5%)	138 (46.5%)
Hypertension[b] or Tx, n (%)	197 (33.2%)	95 (32.0%)	102 (34.3%)
Serum glucose, n	457	234	223
≥ 7.8mmol/L or Tx, n (%)	38 (8.3%)	18 (7.7%)	20 (9.0%)
< 7.8mmol/L, n (%)	419 (91.7%)	216 (92.3%)	203 (91.0%)
Serum Creatinine	586	296	290
≥ 110 mmol/L, n (%)	102 (17.4%)	58 (19.6%)	44 (15.2%)
< 110 mmol/L, n (%)	484 (82.6%)	238 (80.4%)	246 (84.8%)
eGFR[c]	586	296	290
≥ 90ml/min/1.73m^2, n (%)	440 (75.1%)	212 (71.6%)	228 (78.6%)
60-90ml/min/1.73m^2, n (%)	139 (23.7%)	80 (27.0%)	59 (20.3%)
< 60ml/min/1.73m^2, n (%)	7 (1.2%)	4 (1.4%)	3 (1.1%)
Total cholesterol	587	296	291
≥ 5.17 mmol/L, n (%)	140 (23.9%)	77 (26.0%)	63 (21.6%)
< 5.17 mmol/L, n (%)	447 (76.1%)	219 (74.0%)	228 (78.4%)
HDL cholesterol	587		
≤ 1.04 mmol/L, n (%)	151 (25.7%)	79 (26.7%)	72 (24.7%)
> 1.04 mmol/L, n (%)	436 (74.3%)	271 (73.3%)	219 (75.3%)
LDL cholesterol	587	296	291
≥ 3.0 mmol/L, n (%)	217 (37.0%)	113 (38.2%)	104 (35.7%)
< 3.0 mmol/L, n (%)	370 (63.0%)	183 (61.8%)	187 (64.3%)
Triglycerides	587	296	291
≥ 1.7 mmol/L, n (%)	211 (35.9%)	116 (39.2%)	95 (32.6%)
< 1.7 mmol/L, n (%)	376 (64.1%)	180 (60.8%)	196 (67.4%)

Abbreviations: *P*: p-value; IQR: Interquartile range; bpm: beats per minute; Tx: on medication; eGFR: estimated glomerular filtration rate; HDL: High-density-lipoprotein; LDL: Low-density-lipoprotein

[a]: Systolic blood pressure >120mmHg and/or diastolic blood pressure >80mmHg

[b]: Systolic blood pressure >140mmHg and/or diastolic blood pressure >90mmHg

[c]: Calculated using: $186 \times (\text{Creatinine}/88.4)^{-1.154} \times (\text{Age})^{-0.203} \times (0.742 \text{ if female}) \times (1.210 \text{ if black African})$

Table 2. Descriptive statistics of cardiovascular risk assessments

	Participants (n=607)	**Day shifts (n=305)**	**Day-night shifts (n=302)**	***P***

Framingham risk score				
10-year Framingham risk percentage, n	585	295	290	**0.05**
10-year Framingham risk percentage, median (IQR)	3.21 (1.66-5.99)	3.52 (1.95-6.23)	2.98 (1.47-5.56)	
Low risk (< 10%), n (%)	518 (88.5%)	265 (89.8%)	253 (87.2%)	
Intermediate risk (10-20%), n (%)	52 (9.0%)	24 (8.1%)	28 (9.7%)	
High risk (> 20%), n (%)	15 (2.5%)	6 (2.0%)	9 (3.1%)	
ASCVD risk score				
10-year ASCVD risk percentage, n	215	111	104	0.94
10-year ASCVD risk percentage, median (IQR)	5.13 (3.62-7.20)	5.16 (3.64-6.66)	5.12 (3.57-7.63)	
Low risk (< 5%), n (%)	103 (47.9)	54 (48.6%)	49 (47.1%)	
Intermediate risk (5-20%), n (%)	107 (49.8%)	55 (49.5%)	52 (50.0%)	
High risk (≥ 20%), n (%)	5 (2.3%)	2 (1.8%)	3 (2.9%)	
Cornell LVH				
LVH based on Criteria > 2.8mV, n (%)	555	14 (4.9%)	9 (3.3%)	0.33
LVH based on Product > 244mVms, n (%)	547	18 (6.5%)	11 (4.1%)	0.21
Solokow-Lyon LVH				
LVH based on Criteria > 3.5mV, n (%)	581	92 (31.7%)	94 (32.3%)	0.88
LVH combined, n (%)	582	105 (36.1%)	104 (35.7%)	0.93
CIMT				
mean CCA IMT (mm), median (IQR)	217	0.54 (0.50-0.70)	0.52 (0.49-0.59)	0.10
max CCA IMT (mm), median (IQR)	217	0.62 (0.57-0.70)	0.60 (0.55-0.66)	0.12
max bulb IMT (mm), median (IQR)	216	0.70 (0.60-0.86)	0.61 (0.51-0.75)	**0.01**
Carotid plaque, n (%)	216	5 (4.1%)	4 (4.3%)	0.93

Abbreviations: P: *p-value; IQR: Interquartile range; ASCVD: Arteriosclerotic cardiovascular disease; LVH: Left ventricular hypertrophy; CIMT: Carotid intima-media thickness; CCA: Common carotid artery; IMT: Intima media thickness*

Abbreviations

AIGHD: Amsterdam Institute for Global Health and Development

ASCVD: Atherosclerotic Cardiovascular Disease

BMI: Body-Mass Index

CCA: Common Carotid Artery

CIMT: Carotid Intima-Media Thickness

CVD: Cardiovascular Disease

ECG: Electrocardiogram

eGFR: Estimated glomerular filtration rate

FRS: Framingham Risk Score

HDL: High-Density-Lipoprotein

IMT: Intima-Media Thickness

IQR: Interquartile Range

LDL: Low-Density-Lipoprotein

LVH: Left Ventricular Hypertrophy

NSA: North-Star Alliance

OR: Odds Ratio

P: p-value

TG: Triglycerides

WRHI: Wits Reproductive Health and HIV Institute

Appendix

Appendix 1: Uni- and multivariable analysis

Linear regression	Log (FRS)			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift	-0.05 (-0.12-0.01)	0.13	-0.02 (-0.06-0.02)	0.18
Age	0.04 (0.04-0.04)	<0.01	0.04 (0.03-0.04)	**<0.01**
Country of origin				
Zimbabwe	-0.07 (-0.14--0.00)	0.04	-0.01 (-0.07-0.04)	0.68
South Africa	Reference			
Zambia	-0.03 (-0.16-0.10)	0.67	0.04 (-0.03-0.15)	0.28
Other	0.05 (-0.06-0.16)	0.38	0.02 (-0.06-0.08)	0.48
Education level				
Primary school or less	0.13 (0.01-0.25)	0.04	-0.09 (-0.10-0.03)	**0.01**
Secondary school	Reference			
Matrix/college/university	-0.02 (-0.09-0.05)	0.65	0.01 (-0.01-0.07)	0.76
Stable relationship	0.31 (0.20-0.41)	<0.01	0.10 (-0.004-0.12)	**< 0.01**

Linear regression	Log (ASCVD)			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift	-0.03 (-0.08-0.02)	0.28	-0.01 (-0.03-0.02)	0.49
Age	0.03 (0.03-0.03)	<0.01	0.03 (0.03-0.03)	**<0.01**
Country of origin				
Zimbabwe	-0.65 (-0.12--0.01)	0.02	0.001 (-0.03-0.03)	0.97
South Africa	Reference			
Zambia	-0.01 (-0.11-0.09)	0.82	0.04 (-0.01-0.09)	0.13
Other	0.04 (-0.05-0.12)	0.37	0.01 (-0.03-0.06)	0.58
Education level				
Primary school or less	0.10 (0.01-0.19)	0.03	-0.08 (-0.12--0.03)	**< 0.01**
Secondary school	Reference			
Matrix/college/university	-0.02 (-0.08-0.03)	0.38	-0.01 (-0.04-0.02)	0.55
Stable relationship	0.22 (0.14-0.30)	<0.01	0.06 (0.02-0.10)	**< 0.01**

Linear regression	Log (mean CCA-IMT)			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*

Day/night shift	-0.01 (-0.03-0.003)	0.12	-0.003 (-0.02-0.02)	0.74
Age	0.01 (0.004-0.01)	<0.01	0.006 (0.005-0.007)	**<0.01**
Country of origin				
Zimbabwe	-0.01 (-0.04-0.03)	0.74		
South Africa	Reference			
Zambia	-0.02 (-0.07-0.01)	0.24		
Other	-0.04 (-0.05-0.04)	0.83		
Education level				
Primary school or less	0.01 (-0.01-0.04)	0.29		
Secondary school	Reference			
Matrix/college/university	-0.01 (-0.03-0.01)	0.30		
Stable relationship	0.04 (0.01-0.06)	< 0.01	0.008 (-0.02-0.04)	0.61

Binomial logistic regression	**LVH combined**			
	Univariable OR (95% CI)	*P*	Multivariable OR (95% CI)	*P*
Day/night shift	0.99 (0.70-1.38)	0.93	0.94 (0.67-1.33)	0.73
Age	0.98 (0.96-1.00)	0.03	0.99 (0.97-1.00)	0.12
Country of origin				
Zimbabwe	1.34 (0.86-2.08)	0.21		
South Africa	Reference			
Zambia	1.18 (0.55-2.51)	0.67		
Other	1.15 (0.59-2.24)	0.68		
Education level				
Primary school or less	1.36 (0.73-2.52)	0.33		
Secondary school	Reference			
Matrix/college/university	1.21 (0.83-1.74)	0.32		
Stable relationship	0.37 (0.21-0.64)	<0.01	0.40 (0.23-0.70)	**<0.01**

Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

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		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	5

Objectives	#3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	#4	Present key elements of study design early in the paper	6
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	6
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	7
Bias	#9	Describe any efforts to address potential sources of bias	8
Study size	#10	Explain how the study size was arrived at	6
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	8/9

Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	9
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	8/9
Statistical methods	#12c	Explain how missing data were addressed	8
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	-
Statistical methods	#12e	Describe any sensitivity analyses	9
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	9
Participants	#13b	Give reasons for non-participation at each stage	10
Participants	#13c	Consider use of a flow diagram	-
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	11

Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	11
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	11/12
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11/12
Main results	#16b	Report category boundaries when continuous variables were categorized	10/11/12
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	13
Discussion			
Key results	#18	Summarise key results with reference to study objectives	13
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	14

Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	13/14
Generalisability	#21	Discuss the generalisability (external validity) of the study results	14
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

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The influence of shift work on cardiovascular disease risk in Southern African long-distance truck drivers: A cross-sectional study

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The influence of shift work on cardiovascular disease risk in Southern African long-distance truck drivers: A cross-sectional study

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Abstract

Objectives:

Cardiovascular disease (CVD) is a major problem globally. Truck drivers have an increased risk of CVD due to a sedentary lifestyle, irregular working hours and behavioral choices. We aimed to get insight into the contribution of night shift work to CVD risk in long-distance truck drivers in South Africa.

Design:

A cross-sectional study was performed.

Setting:

Enrollment took place at three South African truck stop locations in two provinces; Bloemfontein (Free State), Pomona Road (Gauteng), and Soweto (Gauteng).

Participants:

607 males aged 18 years and older with full-time employment as a long-distance truck driver were included. The criteria for inclusion were willingness and being able to provide informed consent and to complete the study procedures.

Primary and secondary outcome measures:

Information was collected on sociodemographics, occupational and health characteristics. Physical measurements, an electrocardiogram (ECG), and carotid intima-media thickness (CIMT) measurements were taken. A night shift was defined as working at least 3 hours between 10pm and 6am once a week. CVD risk was defined with the Framingham Risk Score (FRS), the Atherosclerotic Cardiovascular Disease (ASCVD) risk algorithm, left ventricular hypertrophy (LVH), and CIMT.

Results:

In total, 607 truck drivers were included of which 305 (50.2%) worked in day shifts only and 302 (49.8%) worked day and night shifts. There was a high prevalence of CVD risk factors in both groups as 33% were hypertensive, 28% obese and 37% had abnormal lipid levels. Working day and night shifts compared to working only day

shifts did not result in differences in FRS, ASCVD risk, or LVH. No difference was found in CIMT measurements, except for the maximum bulb thickness which was higher in day shift workers.

Conclusions:

CVD risk factors are considerably present in male truck drivers in South Africa. CVD risk does not differ between dayshift and day-night shift workers in this cross-sectional analysis.

Article summary

Strengths and limitations of this study

- This study presents the largest cohort of male truck drivers in Africa.
- Data collection was extensive and included demographics, work and life style related risk factors for diseases as well as physical measurements
- Cardiovascular disease risk was assessed with CVD risk scores, ECG and carotid intima media measurements.
- Night shift work was defined in several ways to account for the variation of definitions in literature.
- The influence of night shift work on CVD endpoints was investigated using multivariable regression models.

Study approval

The study was approved by the Human Research Ethics Committee (Medical) of the University of Witwatersrand (reference number M160760).

Introduction

Cardiovascular disease (CVD) is the number one cause of death and a leading cause of disability globally. An estimated 17.9 million people died of CVD in 2016, representing 31% of all global deaths[1,2]. Over 75% of CVD events occur in low- and middle-income countries[3]. In South Africa, CVD is responsible for approximately 20% of all deaths, making it the second leading cause of death after HIV/AIDS[4,5]. The cause of CVD is multifactorial and includes behavioral factors such as smoking, physical inactivity, unhealthy dietary patterns and lifestyle related conditions such as high cholesterol, high blood pressure, high body mass index (BMI) and high waist to hip ratio[6].

Irregular working hours and night shifts are risk factors for CVD. In a large systematic review and meta-analysis published in 2018, which combined the results from 21 cohort and case-control studies with a total of 173.010 unique participants, CVD risk increases with 7.1% for every five years of shift work exposure after the first five years [7]. A second study shows that shift work in a cocoa processing company in Ghana is associated with risk factors of CVD such as higher BMI and higher cholesterol levels[8]. A possible reason for the increase in CVD risk may be circadian misalignment. Circadian misalignment reflects a non-optimal scheduling of behavioral and environmental cycles such as sleep/wake, fasting/feeding, rest/activity, dark/light cycles, with respect to endogenous biological processes governed by the circadian system, such as blood pressure, hormones, and inflammation factors[9].

Truck drivers are a high risk population for CVD by virtue of their occupation with long working hours, frequent shift work, low physical activity and high levels of sedentary behavior. There is a high prevalence of risk factors contributing to CVD in truck drivers in South Africa such as smoking, obesity, hypercholesterolemia, hypertension, and abnormal glucose levels[10,11]. This study aims to gain insight into the contribution of night shift work to CVD risk in long-distance truck drivers in South

Africa by comparing truck drivers who work day shifts only to truck drivers who work day and night shifts.

Methods

Study design and setting

This analysis is a secondary data analysis of The Trucker Health Survey (THS). The THS was an initiative of the Wits Reproductive Health and HIV Institute (Wits RHI), a department of the University of the Witwatersrand, and North-Star Alliance (NSA). NSA provided health care services to truck drivers through a network of Roadside Wellness Centers located at busy truck stops and at border crossings[12]. Methods and characteristics of the THS have been described previously[13]. Enrollment took place between October 2016 and March 2017 in three South African locations in two provinces; Bloemfontein (Free State), Pomona Road (Gauteng), and Soweto (Gauteng). The truck stop in Soweto was added from January to March 2017 to reach a sufficient number of South African participants. Information was collected during a single visit.

The study was approved by the Research Ethics Committee of the University of the Witwatersrand (reference number M160760). Participation was voluntary, and written informed consent was obtained by a research nurse or counselor who spoke the same language as the participant.

Study population and inclusion criteria

Males aged 18 years and older with full-time employment as a long-distance truck driver were included. The criteria for inclusion were willingness and being able to provide informed consent and to complete the study procedures. All participants with data on shift work available were eligible for this analysis.

Patient and Public involvement statement

Patients and the public were not involved in the study design, or in the recruitment to and conduct of the study. Results cannot be disseminated to study participants directly due to insufficient contact information.

Evaluation

Information on socio-demographic (i.e., age, education, country of origin, marital status), occupational (i.e., time spent working, working night shifts), behavioral (i.e., smoking status, physical activity, sleep duration per day) and health (i.e., HIV status, diabetes treatment, hypertension treatment) characteristics were collected using validated questionnaires[14–17]. An overview of the survey and all questionnaires that have been used can be found in the previously published methodology paper[13]. The main definition for night shifts was working at least three hours once a week between 10pm and 6am, the remaining was defined as dayshift workers. Night shift truck drivers worked either one night shift a week, two to three night shifts a week or more than four night shifts a week. We used those different cut-offs in a sensitivity analysis to investigate whether an increased number of nights shifts would be associated with increased CVD risk.

CVD risk was defined with four different outcome measures namely the Framingham Risk Score (FRS), the Atherosclerotic Cardiovascular Disease (ASCVD) risk algorithm, left ventricular hypertrophy (LVH) on electrocardiogram (ECG) and carotid intima-media thickness (CIMT)[18,19].

Physical measurements included measurement of blood pressure, waist and hip circumference, height and weight. Blood was collected for measurement of total cholesterol, high-density-lipoprotein (HDL) cholesterol, low-density-lipoprotein (LDL) cholesterol, triglycerides (TG), random glucose and creatinine. Blood pressure was categorized as normal, pre-hypertension and hypertension[20]. Cut-off points for glucose and cholesterol were chosen according to international guidelines[21,22].

Estimated glomerular filtration rate (eGFR) was calculated using creatinine levels and presented in stages of chronic kidney disease[23].

CVD risk according to the FRS was calculated and categorized in low-, intermediate- and high-CVD risk[18,24]. The ASCVD risk algorithm was calculated for participants between the age of 40 to 70 according to algorithm guidelines[19,22].

A standard 12 lead ECG was performed by a trained nurse with a computer-based ECG device (SE-1515 DP12, EDAN)[25] to record heart rate, rhythm and conduction time. LVH was assessed using Cornell's voltage (RaVL+SV_3), Cornell's product ((RaVL+SV_3) x QRS duration) and Sokolow-Lyon's voltage (SV_1+RV_5). LVH was defined as Cornell's voltage ≥ 28mV, Cornell's product > 2440 mV·ms or Sokolow-Lyon's voltage ≥ 35mV[26–29]. The combined outcome of LVH was deemed positive if one or more criteria indicated LVH.

CIMT was measured in 217 (42.9%) participants, dependent on the availability of a sonographer. A Siemens Acuson p500 ultrasound (Siemens Healthcare (Pty) Ltd, South Africa) with a ≥ 7mHz linear probe was used. Measurements of the near wall and the far wall of the common carotid artery (CCA) were taken at three standardized angles each side using the Meijer's Arc[30]. At bulb level, the far wall was measured at the best visible angle at both sides. The images were analyzed off-line in batch with the semi-automatically Artery Measurement System software (Chalmers University, Götenburg, Sweden). The mean of the mean common carotid artery intima-media thickness (CCA-IMT) and the max of the mean CCA-IMT were calculated by averaging the near and far wall measurements across the three angles on both sides. Mean-max bulb IMT was calculated using bilateral measurements of the bulb far wall. A mean CCA-IMT of > 1.0mm at any of the measured angles was considered a carotid plaque[31,32].

Statistical analysis

Analyses were done using SPSS version 25.0 (SPSS Inc. Chicago, IL, USA). A $p \leq 0.05$ was considered to be statistically significant. Categorical variables were represented

as counts with percentages. All continuous outcomes were non-normally distributed and summarized using median with interquartile range (IQR). Non-normally distributed data was transformed using the Box-Cox technique combined with a goodness of fit test using normal, lognormal and exponential distributions. To test for differences between day and night shift workers a Chi-square test was used for categorical variables and a Mann-Whitney-U test was used for continuous variables. Linear regression for FRS, ASCVD risk and mean CCA-IMT was done after transformation to meet criteria for normal distribution. Binomial logistic regression was used to assess the influence of night shift work on the occurrence of LVH. Variables considered as confounders for all outcomes were age, country of origin, education level and relationship status[33]. We did not adjust for known CVD risk factors as our outcomes represent the cumulative effect of CVD risk factors. The aim is to investigate CVD risk differences between the groups, and not the contribution of individual CVD risk factors to our endpoints. Variables were included in multivariable analysis if the p-value was ≤ 0.20 in univariable analysis. Age was added to the multivariable model independent of the p-value in univariable analysis.

In a sensitivity analysis, above described analyses were repeated using different cut-off points for night shift work, namely one night shift a week, two to three night shifts a week or four or more night shifts a week. Finally, all analyses were repeated including only truck drivers who had been working as a truck driver for more than 10 years (n = 229 out of 607).

Results

In total, 614 male truck drivers completed the survey, of which 607 (99%) had data on shift work available. Nearly half (n=305, 50.2%) worked in day shifts only and 302 drivers (49.8%) worked both day and night shifts (Table 1).

There were no drivers who only worked night shifts. The median age was 37 (IQR: 31-42) years. The majority of the drivers were from Zimbabwe (62.5%), followed by South Africa (20.2%). The drivers had worked for a median duration of 9 (IQR: 5-14)

years as a truck driver. There was a high prevalence of CVD risk factors in both groups as 28% of participants were obese, 33% hypertensive and >35% had abnormal LDL and TG levels. No significant differences were seen between the groups for most of the CVD risk factors. The day-night shift group had a higher activity score (p = 0.02), higher neck circumference (p < 0.01) and a lower waist to hip ratio (p = 0.03) than the participants who worked day shifts only.

Shift work was borderline associated with a difference in FRS (p = 0.05) as continuous outcome, but there was no difference between the groups when categorized in low, intermediate and high risk (p = 0.57).

Shift work was not associated with ASCVD risk score (p = 0.94), LVH occurrence (all p > 0.20) or CIMT, except for max bulb IMT, which was higher in day shift workers compared to day-night shift workers (p < 0.01) (Table 2).

Factors associated with higher FRS and ASCVD in multivariable analysis were increasing age (p < 0.01 for both), having finished primary school or less (p = 0.01 and p < 0.01 respectively), and a stable relationship (p < 0.01 for both). An increase in age (p < 0.01) was associated with an increase in mean CCA-IMT. A stable relationship was positively associated with LVH (p < 0.01) (Appendix 1).

Repeating the analysis using different definitions for night shift work resulted in the same findings (Appendix 2-3). Limiting the analysis to truck drivers who had been working as a truck driver for more than 10 years (n=229) did also not show a difference in CVD outcomes between day and day/night shift workers (Appendix 4).

Discussion

Our study provides insight into the role of shift work on CVD risk in truck drivers in South Africa and possibly sub-Saharan Africa. We did not find an association between shift work and CVD risk according to the FRS strata, the ASCVD risk score, LVH, and CIMT.

Our results are in line with recent studies done in cohorts of hospital workers. A study including female hospital employees showed that shiftwork was not directly linked to CVD risk[34]. Another study on health care workers employed in hospitals found no difference in metabolic risk factors between day and night shift workers[35]. Similar results were seen in a Finnish cohort study with a 20-year follow-up period as no association between shift work and cardiovascular morbidity was observed[36].

However, other studies did find an increased CVD risk for night shift workers. In a systematic review and meta-analysis, shift work for more than five years had a positive and significant dose-response relationship on CVD risk. Shift work less than five years did not have a relation with CVD risk[7]. Another study, also a systematic review and meta-analysis, demonstrated that an increase in shift work of five years was associated with a five percent increase in the risk of CVD[37]. A third single site study with nearly 2000 participants showed that in male petrochemical plant workers, exposure to night shift work for over 20 years leads to a significant higher risk of getting hypertension[38]. Our study lacked data on intension and duration of nightshifts so a dose-response relationship could not be investigated. Secondly, the group of truck drivers in our dataset who worked longer than 20 years was too small to do additional analysis.

Our findings on the abundance of CVD risk factors are in line with other studies that showed that CVD risk factors are notably present in truck drivers[39,40]. In the South African Demographic and Health Survey including almost 14.000 participants with a mean age of 38.5 years, the overall prevalence of hypertension was 30% and the prevalence of obesity was 20%[41]. In a population study in the northern part of South Africa, including 3641 participants (64% males, median age <30 years), 30% of the men had hypertension, 5% were obese and up to 20% had disturbances in lipid levels[42].

In our population the mean age was 37.6 years. Hypertension occurred in 33% of the participants, and 28% were obese. In our study up to 37% of the participants had abnormal lipid levels. To summarize, it seems that in our study there is a comparable

percentage of hypertension, but increased percentage of obesity and abnormal cholesterol levels compared to the general population.

Some limitations need to be mentioned. The first relates to our definition of night shifts, as only 3 hours of work between 10pm and 6am classified someone as a night shift worker. To account for this, we did additional sensitivity analyses using different cut-offs for the number of nights worked in a week. Unfortunately we did not have information on the exact number of hours worked per night nor did we have information on the time a driver had been involved in shiftwork. This limits our analysis on the dose-response relationship between shiftwork and CVD risk.

Another limitation is potential bias due to the healthy worker effect. Workers who are relatively fitter might do night shifts more often and will continue to do night shifts for a longer period of time. More unhealthy workers might possibly switch to day shifts only or to a different job. Although CVD risk factors did not differ between day and night shift workers there might be unmeasured risk factors leading to an underestimation of the influence of night shift work on CVD risk.

The combined LVH outcome may result in an overestimation of the number of participants without also conducting cardiac echocardiography which is considered the gold standard measure. CIMT data were only available for 43% of the participants. This limits the power, but as CIMT scans were omitted randomly and the number of missing scans was evenly divided over the groups, we do not expect that this would result in a bias.

A major strength of this study is the size of the study with 607 truck drivers, of whom half were working day-night shifts. This is the largest cohort of male truck drivers in South Africa and to the best of our knowledge, the largest in Africa. Our data represents the situation in the general truck driver community in South Africa and beyond as drivers from several African countries were included at public truck stops. Another strength is that we defined CVD risk in complementary ways using four

different outcome measures namely FRS, ASCVD, LVH on ECG and CIMT in combination with the wide variety of physical measurements.

Conclusion

CVD risk factors are abundantly present in male long-haul truck drivers in South Africa. CVD risk does not differ between dayshift and day-night shift workers in this cross-sectional analysis. Nevertheless, the high prevalence of CVD risk factors in this male cohort necessitates further investigation to develop and implement strategies to reduce CVD risk.

Author contributions

Designed the study: MD, AGV, WDFV, DEG. Analysed the data and interpreted results: MD, KS, AGV. Wrote the initial draft: MD, AGV. All authors critically reviewed and approved of the final draft.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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The views of this study are those of the authors and do not necessarily reflect the views of any of the funders or the South African and Dutch governments.

Data availability statement

Deidentified participant data are available upon reasonable request by contacting the corresponding author.

Study approval

The study was approved by the Human Research Ethics Committee (Medical) of the University of Witwatersrand (reference number M160760).

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Table 1. Characteristics of the study population

	Participants (n=607)	**Day shifts (n=305)**	**Day-night shifts (n=302)**
Age (years), median (IQR)	37 (31-42)	37 (32-43)	36 (30-42)
Country of origin, n	605	303	302
Zimbabwe, n (%)	378 (62.5%)	188 (62.0%)	190 (62.9%)
South Africa, n (%)	122 (20.2%)	60 (19.8%)	62 (20.5%)
Zambia, n (%)	45 (7.4%)	24 (7.9%)	21 (7.0%)
Other, n (%)	60 (9.9%)	31 (10.2%)	29 (9.6%)
Working as driver (years), median (IQR)	9 (5-14)	9 (5-14)	8 (5-14)
Time spent working per month (days), median (IQR)	20 (15-24)	20 (18-24)	20 (15-24)
Time sleeping/day (hours), median (IQR)	8 (6-9)	8 (6-9)	7.5 (6-9)
Education level, n	585	287	298
Primary school or less, n (%)	51 (8.7%)	32 (11.1%)	19 (6.4%)
Secondary school, n (%)	322 (55.0%)	150 (52.3%)	172 (57.7%)
Matrix/college/university, n (%)	212 (36.2%)	105 (36.6%)	107 (35.9%)
Marital status, n	607	305	302
Stable relationship, n (%)	545 (89.8%)	278 (91.1%)	267 (88.4%)

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No relationship, n (%)	62 (10.2%)	27 (8.9%)	35 (11.6%)
HIV positive, n (%)	54 (8.9%)	24 (7.9%)	30 (9.9%)
Weekly leisure activity score, median (IQR)	17 (0-27)	17 (0-19)	17 (0-31)
Body mass index (kg/cm^2), n	597	298	299
Body mass index < 30 kg/cm^2, n (%)	428 (71.7%)	220 (73.8%)	208 (69.6%)
Body mass index ≥ 30 kg/cm^2, n (%)	169 (28.3%)	78 (26.2%)	91 (30.4%)
Waist to hip ratio, median (IQR)	0.86 (0.81-0.91)	0.87 (0.82-0.92)	0.85 (0.80-0.91)
Neck circumference (cm), median (IQR)	37 (36-39)	37 (35-39)	38 (36-40)
Smoking ever in life, n (%)	90 (14.9%)	47 (15.6%)	43 (14.2%)
Family history for CVD, n (%)	32 (5.3%)	14 (4.7%)	18 (6.0%)
Heart rate (bpm), median (IQR)	75 (66-83)	75 (68-83)	75 (65-83)
Blood pressure classification, n	594	297	297
Normal, n (%)	100 (16.8%)	43 (14.5%)	57 (19.2%)
Pre-hypertension[a], n (%)	297 (50.0%)	159 (53.5%)	138 (46.5%)
Hypertension[b] or Tx, n (%)	197 (33.2%)	95 (32.0%)	102 (34.3%)
Serum glucose, n	457	234	223
≥ 7.8mmol/L or Tx, n (%)	38 (8.3%)	18 (7.7%)	20 (9.0%)
< 7.8mmol/L, n (%)	419 (91.7%)	216 (92.3%)	203 (91.0%)
Serum Creatinine	586	296	290
≥ 110 mmol/L, n (%)	102 (17.4%)	58 (19.6%)	44 (15.2%)
< 110 mmol/L, n (%)	484 (82.6%)	238 (80.4%)	246 (84.8%)
eGFR[c]	586	296	290
≥ 90ml/min/1.73m^2, n (%)	440 (75.1%)	212 (71.6%)	228 (78.6%)
60-90ml/min/1.73m^2, n (%)	139 (23.7%)	80 (27.0%)	59 (20.3%)
< 60ml/min/1.73m^2, n (%)	7 (1.2%)	4 (1.4%)	3 (1.1%)
Total cholesterol	587	296	291
≥ 5.17 mmol/L, n (%)	140 (23.9%)	77 (26.0%)	63 (21.6%)
< 5.17 mmol/L, n (%)	447 (76.1%)	219 (74.0%)	228 (78.4%)
HDL cholesterol	587	296	291
≤ 1.04 mmol/L, n (%)	151 (25.7%)	79 (26.7%)	72 (24.7%)
> 1.04 mmol/L, n (%)	436 (74.3%)	217 (73.3%)	219 (75.3%)
LDL cholesterol	587	296	291

≥ 3.0 mmol/L, n (%)	217 (37.0%)	113 (38.2%)	104 (35.7%)
< 3.0 mmol/L, n (%)	370 (63.0%)	183 (61.8%)	187 (64.3%)
Triglycerides	587	296	291
≥ 1.7 mmol/L, n (%)	211 (35.9%)	116 (39.2%)	95 (32.6%)
< 1.7 mmol/L, n (%)	376 (64.1%)	180 (60.8%)	196 (67.4%)

Abbreviations: *P*: p-value; IQR: Interquartile range; bpm: beats per minute; Tx: on medication; eGFR: estimated glomerular filtration rate; HDL: High-density-lipoprotein; LDL: Low-density-lipoprotein

[a]: Systolic blood pressure >120mmHg and/or diastolic blood pressure >80mmHg

[b]: Systolic blood pressure >140mmHg and/or diastolic blood pressure >90mmHg

[c]: Calculated using: $186 \times (\text{Creatinine}/88.4)^{-1.154} \times (\text{Age})^{-0.203} \times (0.742 \text{ if female}) \times (1.210 \text{ if black African})$

1

Table 2. Descriptive statistics of cardiovascular risk assessments

	Participants (n=607)	**Day shifts (n=305)**	**Day-night shifts (n=302)**	***P***
Framingham risk score				
10-year Framingham risk percentage, n	585	295	290	**0.05**
10-year Framingham risk percentage, median (IQR)	3.21 (1.66-5.99)	3.52 (1.95-6.23)	2.98 (1.47-5.56)	
Low risk (< 10%), n (%)	518 (88.5%)	265 (89.8%)	253 (87.2%)	
Intermediate risk (10-20%), n (%)	52 (9.0%)	24 (8.1%)	28 (9.7%)	
High risk (> 20%), n (%)	15 (2.5%)	6 (2.0%)	9 (3.1%)	
ASCVD risk score				
10-year ASCVD risk percentage, n	215	111	104	0.94
10-year ASCVD risk percentage, median (IQR)	5.13 (3.62-7.20)	5.16 (3.64-6.66)	5.12 (3.57-7.63)	
Low risk (< 5%), n (%)	103 (47.9)	54 (48.6%)	49 (47.1%)	
Intermediate risk (5-20%), n (%)	107 (49.8%)	55 (49.5%)	52 (50.0%)	
High risk (≥ 20%), n (%)	5 (2.3%)	2 (1.8%)	3 (2.9%)	
Cornell LVH				

LVH based on Criteria > 2.8mV, n (%)	555	14 (4.9%)	9 (3.3%)	0.33
LVH based on Product > 244mVms, n (%)	547	18 (6.5%)	11 (4.1%)	0.21
Solokow-Lyon LVH				
LVH based on Criteria > 3.5mV, n (%)	581	92 (31.7%)	94 (32.3%)	0.88
LVH combined, n (%)	582	105 (36.1%)	104 (35.7%)	0.93
CIMT				
mean CCA IMT (mm), median (IQR)	217	0.54 (0.50-0.70)	0.52 (0.49-0.59)	0.10
max CCA IMT (mm), median (IQR)	217	0.62 (0.57-0.70)	0.60 (0.55-0.66)	0.12
max bulb IMT (mm), median (IQR)	216	0.70 (0.60-0.86)	0.61 (0.51-0.75)	**0.01**
Carotid plaque, n (%)	216	5 (4.1%)	4 (4.3%)	0.93

Abbreviations: P: *p-value; IQR: Interquartile range; ASCVD: Arteriosclerotic cardiovascular disease; LVH: Left ventricular hypertrophy; CIMT: Carotid intima-media thickness; CCA: Common carotid artery; IMT: Intima media thickness*

1

Appendix

Appendix 1: Uni- and multivariable analysis

Linear regression	Log (FRS)			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift	-0.05 (-0.12-0.01)	0.13	-0.02 (-0.06-0.02)	0.18
Age	0.04 (0.04-0.04)	<0.01	0.04 (0.03-0.04)	**<0.01**
Country of origin				
Zimbabwe	-0.07 (-0.14--0.00)	0.04	-0.01 (-0.07-0.04)	0.68
South Africa	Reference			
Zambia	-0.03 (-0.16-0.10)	0.67	0.04 (-0.03-0.15)	0.28
Other	0.05 (-0.06-0.16)	0.38	0.02 (-0.06-0.08)	0.48
Education level				
Primary school or less	0.13 (0.01-0.25)	0.04	-0.09 (-0.10-0.03)	**0.01**
Secondary school	Reference			
Matrix/college/university	-0.02 (-0.09-0.05)	0.65	0.01 (-0.01-0.07)	0.76
Stable relationship	0.31 (0.20-0.41)	<0.01	0.10 (-0.004-0.12)	**< 0.01**

Linear regression	Log (ASCVD)			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift	-0.03 (-0.08-0.02)	0.28	-0.01 (-0.03-0.02)	0.49
Age	0.03 (0.03-0.03)	<0.01	0.03 (0.03-0.03)	**<0.01**
Country of origin				
Zimbabwe	-0.65 (-0.12--0.01)	0.02	0.001 (-0.03-0.03)	0.97
South Africa	Reference			
Zambia	-0.01 (-0.11-0.09)	0.82	0.04 (-0.01-0.09)	0.13

Other	0.04 (-0.05-0.12)	0.37	0.01 (-0.03-0.06)	0.58
Education level				
Primary school or less	0.10 (0.01-0.19)	0.03	-0.08 (-0.12--0.03)	**< 0.01**
Secondary school	Reference			
Matrix/college/university	-0.02 (-0.08-0.03)	0.38	-0.01 (-0.04-0.02)	0.55
Stable relationship	0.22 (0.14-0.30)	<0.01	0.06 (0.02-0.10)	**< 0.01**

Linear regression	**Log (mean CCA-IMT)**			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift	-0.01 (-0.03-0.003)	0.12	-0.003 (-0.02-0.02)	0.74
Age	0.01 (0.004-0.01)	<0.01	0.006 (0.005-0.007)	**<0.01**
Country of origin				
Zimbabwe	-0.01 (-0.04-0.03)	0.74		
South Africa	Reference			
Zambia	-0.02 (-0.07-0.01)	0.24		
Other	-0.04 (-0.05-0.04)	0.83		
Education level				
Primary school or less	0.01 (-0.01-0.04)	0.29		
Secondary school	Reference			
Matrix/college/university	-0.01 (-0.03-0.01)	0.30		
Stable relationship	0.04 (0.01-0.06)	< 0.01	0.008 (-0.02-0.04)	0.61

Binomial logistic regression	**LVH combined**			
	Univariable OR (95% CI)	*P*	Multivariable OR (95% CI)	*P*
Day/night shift	0.99 (0.70-1.38)	0.93	0.94 (0.67-1.33)	0.73
Age	0.98 (0.96-1.00)	0.03	0.99 (0.97-1.00)	0.12
Country of origin				
Zimbabwe	1.34 (0.86-2.08)	0.21		

South Africa	Reference			
Zambia	1.18 (0.55-2.51)	0.67		
Other	1.15 (0.59-2.24)	0.68		
Education level				
Primary school or less	1.36 (0.73-2.52)	0.33		
Secondary school	Reference			
Matrix/college/university	1.21 (0.83-1.74)	0.32		
Stable relationship	0.37 (0.21-0.64)	<0.01	0.40 (0.23-0.70)	**<0.01**

Appendix 2: Sensitivity analysis, definition night shift worker is working two to three night shift a week

Linear regression	**Log (FRS)**			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift (2-3 nights)	-0.03 (-0.10-0.04)	0.34	-0.03 (-0.06-0.01)	0.15
Age	0.04 (0.04-0.04)	<0.01	0.04 (0.04-0.04)	**<0.01**
Country of origin				
Zimbabwe	-0.07 (-0.14--0.00)	0.04	0.01 (-0.04-0.05)	0.75
South Africa	Reference			
Zambia	-0.03 (-0.16-0.10)	0.67	0.04 (-0.04-0.11)	0.31
Other	0.05 (-0.06-0.16)	0.38	0.02 (-0.04-0.09)	0.51
Education level				
Primary school or less	0.13 (0.01-0.25)	0.04	-0.09 (-0.15--0.02)	**<0.01**
Secondary school	Reference			
Matrix/college/university	-0.02 (-0.09-0.05)	0.65	0.01(-0.03-0.04)	0.79
Stable relationship	0.31 (0.20-0.41)	<0.01	0.10 (0.05-0.16)	**<0.01**

Linear regression	**Log (ASCVD)**

	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift (2-3 nights)	-0.01 (-0.07-0.04)	0.63	-0.01 (-0.03-0.02)	0.48
Age	0.03 (0.03-0.03)	<0.01	0.03 (0.03-0.03)	**<0.01**
Country of origin				
Zimbabwe	-0.65 (-0.12--0.01)	0.02	0.00 (-0.03-0.03)	0.99
South Africa	Reference			
Zambia	-0.01 (-0.11-0.09)	0.82	0.04 (-0.01-0.09)	0.14
Other	0.04 (-0.05-0.12)	0.37	0.01 (-0.03-0.06)	0.59
Education level				
Primary school or less	0.10 (0.01-0.19)	0.03	-0.08 (-0.12-0.03)	**< 0.01**
Secondary school	Reference			
Matrix/college/university	-0.02 (-0.08-0.03)	0.38	-0.01 (-0.04-0.02)	0.53
Stable relationship	0.22 (0.14-0.30)	<0.01	0.06 (0.02-0.10)	**< 0.01**

Linear regression	**Log (mean CCA-IMT)**			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift (2-3 nights)	-0.03 (-0.09-0.03)	0.36	-0.004 (-0.04-0.03)	0.82
Age	0.01 (0.004-0.01)	<0.01	0.03 (0.03-0.03)	**<0.01**
Country of origin				
Zimbabwe	-0.01 (-0.04-0.03)	0.74		
South Africa	Reference			
Zambia	-0.02 (-0.07-0.01)	0.24		
Other	-0.04 (-0.05-0.04)	0.83		
Education level				
Primary school or less	0.01 (-0.01-0.04)	0.29		
Secondary school	Reference			
Matrix/college/university	-0.01 (-0.03-0.01)	0.30		

Stable relationship	0.04 (0.01-0.06)	< 0.01	0.05 (-0.01-0.10)	0.09

Binomial logistic regression	**LVH combined**			
	Univariable OR (95% CI)	*P*	Multivariable OR (95% CI)	*P*
Day/night shift (2-3 nights)	0.99 (0.68-1.45)	0.91	0.92 (0.69-1.42)	0.79
Age	0.98 (0.96-1.00)	0.03	0.98 (0.97-1.00)	0.11
Country of origin				
Zimbabwe	1.34 (0.86-2.08)	0.21		
South Africa	Reference			
Zambia	1.18 (0.55-2.51)	0.67		
Other	1.15 (0.59-2.24)	0.68		
Education level				
Primary school or less	1.36 (0.73-2.52)	0.33		
Secondary school	Reference			
Matrix/college/university	1.21 (0.83-1.74)	0.32		
Stable relationship	0.37 (0.21-0.64)	<0.01	0.45 (0.25-0.78)	**<0.01**

Appendix 3: Sensitivity analysis, definition night shift worker is working four or more night shift a week

Linear regression	**Log (FRS)**			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift (4 or more nights)	-0.05 (-0.15-0.05)	0.37	0.002 (-0.05-0.05)	0.93
Age	0.04 (0.04-0.04)	<0.01	0.04 (0.04-0.04)	**<0.01**
Country of origin				
Zimbabwe	-0.07 (-0.14--0.00)	0.04	0.01 (-0.04-0.06)	0.70
South Africa	Reference			

Zambia	-0.03 (-0.16-0.10)	0.67	0.04 (-0.03-0.12)	0.28
Other	0.05 (-0.06-0.16)	0.38	0.02 (-0.04-0.09)	0.47
Education level				
Primary school or less	0.13 (0.01-0.25)	0.04	-0.09 (-0.15--0.02)	**<0.01**
Secondary school	Reference			
Matrix/college/university	-0.02 (-0.09-0.05)	0.65	0.01 (-0.03-0.04)	0.73
Stable relationship	0.31 (0.20-0.41)	<0.01	0.10 (0.05-0.16)	**<0.01**

Linear regression	**Log (ASCVD)**			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift (4 or more nights)	-0.04 (-0.11-0.04)	0.35	0.00 (-0.04-0.04)	0.99
Age	0.03 (0.03-0.03)	<0.01	0.03 (0.03-0.03)	**<0.01**
Country of origin				
Zimbabwe	-0.65 (-0.12--0.01)	0.02	0.00 (-0.03-0.03)	0.98
South Africa	Reference			
Zambia	-0.01 (-0.11-0.09)	0.82	0.04 (-0.01-0.09)	0.13
Other	0.04 (-0.05-0.12)	0.37	0.01 (-0.03-0.06)	0.57
Education level				
Primary school or less	0.10 (0.01-0.19)	0.03	-0.07 (-0.12--0.03)	**< 0.01**
Secondary school	Reference			
Matrix/college/university	-0.02 (-0.08-0.03)	0.38	-0.01 (-0.03-0.02)	0.56
Stable relationship	0.22 (0.14-0.30)	<0.01	0.06 (0.02-0.10)	**< 0.01**

Linear regression	**Log (mean CCA-IMT)**			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*

Day/night shift (4 or more nights)	-0.05 (-0.14-0.03)	0.21	-0.02 (-0.07-0.03)	0.39
Age	0.01 (0.004-0.01)	<0.01	0.03 (0.03-0.03)	**<0.01**
Country of origin				
Zimbabwe	-0.01 (-0.04-0.03)	0.74		
South Africa	Reference			
Zambia	-0.02 (-0.07-0.01)	0.24		
Other	-0.04 (-0.05-0.04)	0.83		
Education level				
Primary school or less	0.01 (-0.01-0.04)	0.29		
Secondary school	Reference			
Matrix/college/university	-0.01 (-0.03-0.01)	0.30		
Stable relationship	0.04 (0.01-0.06)	< 0.01	0.05 (-0.01-0.10)	0.10

Binomial logistic regression	**LVH combined**			
	Univariable OR (95% CI)	*P*	Multivariable OR (95% CI)	*P*
Day/night shift (4 or more nights)	0.99 (0.81-1.18)	0.95	0.93 (0.73-1.28)	0.79
Age	0.98 (0.96-1.00)	0.03	0.99 (0.98-1.00)	0.10
Country of origin				
Zimbabwe	1.34 (0.86-2.08)	0.21		
South Africa	Reference			
Zambia	1.18 (0.55-2.51)	0.67		
Other	1.15 (0.59-2.24)	0.68		
Education level				
Primary school or less	1.36 (0.73-2.52)	0.33		
Secondary school	Reference			
Matrix/college/university	1.21 (0.83-1.74)	0.32		
Stable relationship	0.37 (0.21-0.64)	<0.01	0.41 (0.28-0.65)	**<0.01**

Appendix 4: Sensitivity analysis including only truck drivers working more than 10 years as a truck driver

Linear regression	Log (FRS)			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift	0.12 (-0.08-0.33)	0.24	0.06 (-0.06-0.19)	0.32
Age	0.08 (0.07- 0.09)	<0.01	0.08 (0.07-0.08)	**<0.01**
Country of origin				
Zimbabwe	-0.42 (-0.69--0.16)	0.36		
South Africa	Reference			
Zambia	-0.12 (-0.54-0.31)	0.59		
Other	0.15 (-0.51-0.21)	0.41		
Education level				
Primary school or less	0.17 (-0.14-0.47)	0.28		
Secondary school	Reference			
Matrix/college/university	0.18 (-0.05-0.42)	0.24		
Stable relationship	0.59 (0.16-0.1.02)	0.07	0.27 (0.01-0.54)	**0.04**

Linear regression	Log (ASCVD)			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift	0.04 (-0.03-0.11)	0.27	0.02 (-0.02-0.06)	0.38
Age	0.03 (0.03-0.03)	<0.01	0.03 (0.02-0.03)	**< 0.01**
Country of origin				
Zimbabwe	-0.03 (-0.12--0.01)	0.26		
South Africa	Reference			
Zambia	-0.01 (-0.15-0.12)	0.75		
Other	0.03 (-0.04-0.14)	0.37		

Education level				
Primary school or less	0.08 (0.01-0.11)	0.56		
Secondary school	Reference			
Matrix/college/university	-0.03 (-0.07-0.04)	0.34		
Stable relationship	0.28 (0.19-0.33)	<0.01	0.07 (-0.01-0.15)	0.08

Linear regression	**Log (mean CCA-IMT)**			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift	-0.01 (-0.01-0.003)	0.15	-0.03 (-0.08-0.001)	0.05
Age	0.01 (0.005-0.01)	<0.01	0.008 (0.005-0.01)	**<0.01**
Country of origin				
Zimbabwe	-0.02 (-0.05-0.04)	0.72		
South Africa	Reference			
Zambia	-0.03 (-0.08-0.02)	0.35		
Other	-0.05 (-0.06-0.05)	0.77		
Education level				
Primary school or less	0.01 (-0.01-0.05)	0.28		
Secondary school	Reference			
Matrix/college/university	-0.01 (-0.04-0.01)	0.38		
Stable relationship	0.04 (0.01-0.05)	< 0.01	0.018 (-0.1-0.13)	0.75

Binomial logistic regression	**LVH combined**			
	Univariable OR (95% CI)	*P*	Multivariable OR (95% CI)	*P*
Day/night shift	0.98 (0.73-1.45)	0.91	0.92 (0.65-1.31)	0.78
Age	0.99 (0.97-1.00)	0.04	0.99 (0.96-1.00)	0.08
Country of origin				
Zimbabwe	1.62 (0.96-2.25)	0.25		
South Africa	Reference			

Zambia	1.21 (0.53-2.66)	0.75		
Other	1.12 (0.54-2.22)	0.58		
Education level				
Primary school or less	1.36 (0.73-2.52)	0.33		
Secondary school	Reference			
Matrix/college/university	1.21 (0.83-1.74)	0.32		
Stable relationship	0.34 (0.23-0.69)	<0.01	0.51 (0.33-0.84)	**<0.01**

Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

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		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	5

Objectives	#3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	#4	Present key elements of study design early in the paper	6
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	6
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	7
Bias	#9	Describe any efforts to address potential sources of bias	8
Study size	#10	Explain how the study size was arrived at	6
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	8/9

Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	9
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	8/9
Statistical methods	#12c	Explain how missing data were addressed	8
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	-
Statistical methods	#12e	Describe any sensitivity analyses	9
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	9
Participants	#13b	Give reasons for non-participation at each stage	10
Participants	#13c	Consider use of a flow diagram	-
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	11

Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	11
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	11/12
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11/12
Main results	#16b	Report category boundaries when continuous variables were categorized	10/11/12
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	13
Discussion			
Key results	#18	Summarise key results with reference to study objectives	13
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	14

Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	13/14
Generalisability	#21	Discuss the generalisability (external validity) of the study results	14
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

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The influence of shift work on cardiovascular disease risk in Southern African long-distance truck drivers: A cross-sectional study

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The influence of shift work on cardiovascular disease risk in Southern African long-distance truck drivers: A cross-sectional study

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Abstract

Objectives:

Cardiovascular disease (CVD) is a major problem globally. Truck drivers have an increased risk of CVD due to a sedentary lifestyle, irregular working hours and behavioral choices. We aimed to get insight into the contribution of night shift work to CVD risk in long-distance truck drivers in South Africa.

Design:

A cross-sectional study.

Setting:

Enrollment took place at three South African truck stop locations in two provinces; Bloemfontein (Free State), Pomona Road (Gauteng), and Soweto (Gauteng).

Participants:

607 males aged ≥18 years with full-time employment as a long-distance truck driver were included. The criteria for inclusion were willingness and being able to provide informed consent and to complete the study procedures.

Primary and secondary outcome measures:

Information was collected on sociodemographics, occupational and health characteristics. Physical measurements, an electrocardiogram (ECG), and carotid intima-media thickness (CIMT) measurements were taken. A night shift was defined as working at least 3 hours between 10pm and 6am once a week. CVD risk was defined with the Framingham Risk Score (FRS), the Atherosclerotic Cardiovascular Disease (ASCVD) risk algorithm, left ventricular hypertrophy (LVH), and CIMT.

Results:

In total, 607 truck drivers were included of which 305 (50.2%) worked in day shifts only and 302 (49.8%) worked day and night shifts. There was a high prevalence of CVD risk factors in both groups as 33% were hypertensive, 28% obese and 37% had abnormal lipid levels. Working day and night shifts compared to working only day

shifts did not result in differences in FRS, ASCVD risk, or LVH. No difference was found in CIMT measurements, except for the maximum bulb thickness which was higher in day shift workers.

Conclusions:

CVD risk factors are considerably present in male truck drivers in South Africa. CVD risk does not differ between dayshift and day-night shift workers in this cross-sectional analysis.

Article summary

Strengths and limitations of this study

- This study presents the largest cohort of male truck drivers in Africa.
- Data collection was extensive and included demographics, work and life style related risk factors for diseases as well as physical measurements
- Cardiovascular disease risk was assessed with CVD risk scores, ECG and carotid intima media measurements.
- Night shift work was defined in several ways to account for the variation of definitions in literature.
- The influence of night shift work on CVD endpoints was investigated using multivariable regression models.

Study approval

The study was approved by the Human Research Ethics Committee (Medical) of the University of Witwatersrand (reference number M160760).

Introduction

Cardiovascular disease (CVD) is the number one cause of death and a leading cause of disability globally. An estimated 17.9 million people died of CVD in 2016, representing 31% of all global deaths[1,2]. Over 75% of CVD events occur in low- and middle-income countries[3]. In South Africa, CVD is responsible for approximately 20% of all deaths, making it the second leading cause of death after HIV/AIDS[4,5]. The cause of CVD is multifactorial and includes behavioral factors such as smoking, physical inactivity, unhealthy dietary patterns and lifestyle related conditions such as high cholesterol, high blood pressure, high body mass index (BMI) and high waist to hip ratio[6].

Irregular working hours and night shifts are risk factors for CVD. In a large systematic review and meta-analysis published in 2018, which combined the results from 21 cohort and case-control studies with a total of 173.010 unique participants, CVD risk increases with 7.1% for every five years of shift work exposure after the first five years [7]. A second study shows that shift work in a cocoa processing company in Ghana is associated with risk factors of CVD such as higher BMI and higher cholesterol levels[8]. A possible reason for the increase in CVD risk may be circadian misalignment. Circadian misalignment reflects a non-optimal scheduling of behavioral and environmental cycles such as sleep/wake, fasting/feeding, rest/activity, dark/light cycles, with respect to endogenous biological processes governed by the circadian system, such as blood pressure, hormones, and inflammation factors[9].

Truck drivers are a high risk population for CVD by virtue of their occupation with long working hours, frequent shift work, low physical activity and high levels of sedentary behavior. There is a high prevalence of risk factors contributing to CVD in truck drivers in South Africa such as smoking, obesity, hypercholesterolemia, hypertension, and abnormal glucose levels[10,11]. This study aims to gain insight into the contribution of night shift work to CVD risk in long-distance truck drivers in South

Africa by comparing truck drivers who work day shifts only to truck drivers who work day and night shifts.

Methods

Study design and setting

This analysis is a secondary data analysis of The Trucker Health Survey (THS). The THS was an initiative of the Wits Reproductive Health and HIV Institute (Wits RHI), a department of the University of the Witwatersrand, and North-Star Alliance (NSA). NSA provided health care services to truck drivers through a network of Roadside Wellness Centers located at busy truck stops and at border crossings[12]. Methods and characteristics of the THS have been described previously[13]. Enrollment took place between October 2016 and March 2017 in three South African locations in two provinces; Bloemfontein (Free State), Pomona Road (Gauteng), and Soweto (Gauteng). The truck stop in Soweto was added from January to March 2017 to reach a sufficient number of South African participants. Information was collected during a single visit.

The study was approved by the Research Ethics Committee of the University of the Witwatersrand (reference number M160760). Participation was voluntary, and written informed consent was obtained by a research nurse or counselor who spoke the same language as the participant.

Study population and inclusion criteria

Males aged 18 years and older with full-time employment as a long-distance truck driver were included. The criteria for inclusion were willingness and being able to provide informed consent and to complete the study procedures. All participants with data on shift work available were eligible for this analysis.

Patient and Public involvement statement

Patients and the public were not involved in the study design, or in the recruitment to and conduct of the study. Results cannot be disseminated to study participants directly due to insufficient contact information.

Evaluation

Information on socio-demographic (i.e., age, education, country of origin, marital status), occupational (i.e., time spent working, working night shifts), behavioral (i.e., smoking status, physical activity, sleep duration per day) and health (i.e., HIV status, diabetes treatment, hypertension treatment) characteristics were collected using validated questionnaires[14–17]. An overview of the survey and all questionnaires that have been used can be found in the previously published methodology paper[13]. The main definition for night shifts was working at least three hours once a week between 10pm and 6am, the remaining was defined as dayshift workers. Night shift truck drivers worked either one night shift a week, two to three night shifts a week or more than four night shifts a week. We used those different cut-offs in a sensitivity analysis to investigate whether an increased number of nights shifts would be associated with increased CVD risk.

CVD risk was defined with four different outcome measures namely the Framingham Risk Score (FRS), the Atherosclerotic Cardiovascular Disease (ASCVD) risk algorithm, left ventricular hypertrophy (LVH) on electrocardiogram (ECG) and carotid intima-media thickness (CIMT)[18,19].

Physical measurements included measurement of blood pressure, waist and hip circumference, height and weight. Blood was collected for measurement of total cholesterol, high-density-lipoprotein (HDL) cholesterol, low-density-lipoprotein (LDL) cholesterol, triglycerides (TG), random glucose and creatinine. Blood pressure was categorized as normal, pre-hypertension and hypertension[20]. Cut-off points for glucose and cholesterol were chosen according to international guidelines[21,22].

Estimated glomerular filtration rate (eGFR) was calculated using creatinine levels and presented in stages of chronic kidney disease[23].

CVD risk according to the FRS was calculated and categorized in low-, intermediate- and high-CVD risk[18,24]. The ASCVD risk algorithm was calculated for participants between the age of 40 to 70 according to algorithm guidelines[19,22].

A standard 12 lead ECG was performed by a trained nurse with a computer-based ECG device (SE-1515 DP12, EDAN)[25] to record heart rate, rhythm and conduction time. LVH was assessed using Cornell's voltage (RaVL+SV_3), Cornell's product ((RaVL+SV_3) x QRS duration) and Sokolow-Lyon's voltage (SV_1+RV_5). LVH was defined as Cornell's voltage ≥ 28mV, Cornell's product > 2440 mV·ms or Sokolow-Lyon's voltage ≥ 35mV[26–29]. The combined outcome of LVH was deemed positive if one or more criteria indicated LVH.

CIMT was measured in 217 (42.9%) participants, dependent on the availability of a sonographer. A Siemens Acuson p500 ultrasound (Siemens Healthcare (Pty) Ltd, South Africa) with a ≥ 7mHz linear probe was used. Measurements of the near wall and the far wall of the common carotid artery (CCA) were taken at three standardized angles each side using the Meijer's Arc[30]. At bulb level, the far wall was measured at the best visible angle at both sides. The images were analyzed off-line in batch with the semi-automatically Artery Measurement System software (Chalmers University, Götenburg, Sweden). The mean of the mean common carotid artery intima-media thickness (CCA-IMT) and the max of the mean CCA-IMT were calculated by averaging the near and far wall measurements across the three angles on both sides. Mean-max bulb IMT was calculated using bilateral measurements of the bulb far wall. A mean CCA-IMT of > 1.0mm at any of the measured angles was considered a carotid plaque[31,32].

Statistical analysis

Analyses were done using SPSS version 25.0 (SPSS Inc. Chicago, IL, USA). A $p \leq 0.05$ was considered to be statistically significant. Categorical variables were represented

as counts with percentages. All continuous outcomes were non-normally distributed and summarized using median with interquartile range (IQR). Non-normally distributed data was transformed using the Box-Cox technique combined with a goodness of fit test using normal, lognormal and exponential distributions. To test how cardiovascular measures differed between day and night shift workers a Chi-square test was used for categorical outcomes and a Mann-Whitney-U test was used for continuous outcomes. Next, regression analysis was used to assess the influence of shift work on FRS, ASCVD risk, mean CCA-IMT and LVH while adjusting for confounders. Variables considered as confounders were age, country of origin, education level and relationship status[33]. We did not adjust for known CVD risk factors as outcomes represent the cumulative effect of CVD risk factors. Variables were included in multivariable analysis if the p-value was ≤ 0.20 in univariable analysis. Age was added to the multivariable model independent of the p-value in univariable analysis. FRS, ASCVD and mean CCA-IMT were log transformed to meet criteria for normal distribution.

In a sensitivity analysis, above described analyses were repeated using different cut-off points for night shift work, namely zero to one night shift a week, two to three night shifts a week or four or more night shifts a week. Finally, all analyses were repeated including only truck drivers who had been working as a truck driver for more than 10 years (n = 229 out of 607).

Results

In total, 614 male truck drivers completed the survey, of which 607 (99%) had data on shift work available. Nearly half (n=305, 50.2%) worked in day shifts only and 302 drivers (49.8%) worked both day and night shifts (Table 1).

There were no drivers who only worked night shifts. The median age was 37 (IQR: 31-42) years. The majority of the drivers were from Zimbabwe (62.5%), followed by South Africa (20.2%). The drivers had worked for a median duration of 9 (IQR: 5-14) years as a truck driver. There was a high prevalence of CVD risk factors in both groups

as 28% of participants were obese, 33% hypertensive and >35% had abnormal LDL and TG levels. No significant differences were seen between the groups for most of the CVD risk factors. The day-night shift group had a higher activity score ($p = 0.02$), higher neck circumference ($p < 0.01$) and a lower waist to hip ratio ($p = 0.03$) than the participants who worked day shifts only.

Shift work was borderline associated with a difference in FRS ($p = 0.05$) as continuous outcome, but there was no difference between the groups when categorized in low, intermediate and high risk ($p = 0.57$). Shift work was not associated with ASCVD risk score ($p = 0.94$), LVH occurrence (all $p > 0.20$) or CIMT, except for max bulb IMT, which was higher in day shift workers compared to day-night shift workers ($p < 0.01$) (Table 2).

Following multivariable regression analysis shift work was not associated with any of the cardiovascular outcomes. Factors associated with higher FRS and ASCVD were increasing age ($p < 0.01$ for both), having finished primary school or less ($p = 0.01$ and $p < 0.01$ respectively), and a stable relationship ($p < 0.01$ for both). An increase in age ($p < 0.01$) was associated with an increase in mean CCA-IMT. A stable relationship was positively associated with LVH ($p < 0.01$) (Appendix 1).

Repeating the analysis using different definitions for night shift work resulted in the same findings (Appendix 2-3). Limiting the analysis to truck drivers who had been working as a truck driver for more than 10 years (n=229) did also not show a difference in CVD outcomes between day and day-night shift workers (Appendix 4).

Discussion

Our study provides insight into the role of shift work on CVD risk in truck drivers in South Africa and possibly sub-Saharan Africa. We did not find an association between shift work and CVD risk according to the FRS strata, the ASCVD risk score, LVH, and CIMT.

Our results are in line with recent studies done in cohorts of hospital workers. A study including female hospital employees showed that shiftwork was not directly linked to CVD risk[34]. Another study on health care workers employed in hospitals found no difference in metabolic risk factors between day and night shift workers[35]. Similar results were seen in a Finnish cohort study with a 20-year follow-up period as no association between shift work and cardiovascular morbidity was observed[36].

However, other studies did find an increased CVD risk for night shift workers. In a systematic review and meta-analysis, shift work for more than five years had a positive and significant dose-response relationship on CVD risk. Shift work less than five years did not have a relation with CVD risk[7]. Another study, also a systematic review and meta-analysis, demonstrated that an increase in shift work of five years was associated with a five percent increase in the risk of CVD[37]. A third single site study with nearly 2000 participants showed that in male petrochemical plant workers, exposure to night shift work for over 20 years leads to a significant higher risk of getting hypertension[38]. Our study lacked data on intension and duration of nightshifts so a dose-response relationship could not be investigated. Secondly, the group of truck drivers in our dataset who worked longer than 20 years was too small to do additional analysis.

Our findings on the abundance of CVD risk factors are in line with other studies that showed that CVD risk factors are notably present in truck drivers[39,40]. In the South African Demographic and Health Survey including almost 14.000 participants with a mean age of 38.5 years, the overall prevalence of hypertension was 30% and the prevalence of obesity was 20%[41]. In a population study in the northern part of South Africa, including 3641 participants (64% males, median age <30 years), 30% of the men had hypertension, 5% were obese and up to 20% had disturbances in lipid levels[42].

In our population the mean age was 37.6 years. Hypertension occurred in 33% of the participants, and 28% were obese. In our study up to 37% of the participants had abnormal lipid levels. To summarize, it seems that in our study there is a comparable

percentage of hypertension, but increased percentage of obesity and abnormal cholesterol levels compared to the general population.

Some limitations need to be mentioned. The first relates to our definition of night shifts, as only 3 hours of work between 10pm and 6am classified someone as a night shift worker. To account for this, we did additional sensitivity analyses using different cut-offs for the number of nights worked in a week. Unfortunately we did not have information on the exact number of hours worked per night nor did we have information on the time a driver had been involved in shiftwork. This limits our analysis on the dose-response relationship between shiftwork and CVD risk.

Another limitation is potential bias due to the healthy worker effect. Workers who are relatively fitter might do night shifts more often and will continue to do night shifts for a longer period of time. More unhealthy workers might possibly switch to day shifts only or to a different job. Although CVD risk factors did not differ between day and night shift workers there might be unmeasured risk factors leading to an underestimation of the influence of night shift work on CVD risk.

The combined LVH outcome may result in an overestimation of the number of participants without also conducting cardiac echocardiography which is considered the gold standard measure. CIMT data were only available for 43% of the participants. This limits the power, but as CIMT scans were omitted randomly and the number of missing scans was evenly divided over the groups, we do not expect that this would result in a bias.

A major strength of this study is the size of the study with 607 truck drivers, of whom half were working day-night shifts. This is the largest cohort of male truck drivers in South Africa and to the best of our knowledge, the largest in Africa. Our data represents the situation in the general truck driver community in South Africa and beyond as drivers from several African countries were included at public truck stops. Another strength is that we defined CVD risk in complementary ways using four

different outcome measures namely FRS, ASCVD, LVH on ECG and CIMT in combination with the wide variety of physical measurements.

Conclusion

CVD risk factors are abundantly present in male long-haul truck drivers in South Africa. CVD risk does not differ between dayshift and day-night shift workers in this cross-sectional analysis. Nevertheless, the high prevalence of CVD risk factors in this male cohort necessitates further investigation to develop and implement strategies to reduce CVD risk.

Author contributions

Designed the study: MD, AGV, WDFV, DEG. Acquisition of data: SLE, WDFV, AGV. Analysed the data and interpreted results: MD, KS, STLE, AF, AGV. Wrote the initial draft: MD, AGV. All authors critically reviewed and approved of the final draft.

Conflict of interest statement

The authors declare that there is no conflict of interest.

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The views of this study are those of the authors and do not necessarily reflect the views of any of the funders or the South African and Dutch governments.

Data availability statement

Deidentified participant data are available upon reasonable request by contacting the corresponding author.

Study approval

The study was approved by the Human Research Ethics Committee (Medical) of the University of Witwatersrand (reference number M160760).

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Table 1. Characteristics of the study population

	Participants (n=607)	**Day shifts (n=305)**	**Day-night shifts (n=302)**
Age (years), median (IQR)	37 (31-42)	37 (32-43)	36 (30-42)
Country of origin, n	605	303	302
Zimbabwe, n (%)	378 (62.5%)	188 (62.0%)	190 (62.9%)
South Africa, n (%)	122 (20.2%)	60 (19.8%)	62 (20.5%)
Zambia, n (%)	45 (7.4%)	24 (7.9%)	21 (7.0%)
Other, n (%)	60 (9.9%)	31 (10.2%)	29 (9.6%)
Working as driver (years), median (IQR)	9 (5-14)	9 (5-14)	8 (5-14)
Time spent working per month (days), median (IQR)	20 (15-24)	20 (18-24)	20 (15-24)
Time sleeping/day (hours), median (IQR)	8 (6-9)	8 (6-9)	7.5 (6-9)
Education level, n	585	287	298
Primary school or less, n (%)	51 (8.7%)	32 (11.1%)	19 (6.4%)
Secondary school, n (%)	322 (55.0%)	150 (52.3%)	172 (57.7%)
Matrix/college/university, n (%)	212 (36.2%)	105 (36.6%)	107 (35.9%)
Marital status, n	607	305	302
Stable relationship, n (%)	545 (89.8%)	278 (91.1%)	267 (88.4%)

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No relationship, n (%)	62 (10.2%)	27 (8.9%)	35 (11.6%)
HIV positive, n (%)	54 (8.9%)	24 (7.9%)	30 (9.9%)
Weekly leisure activity score, median (IQR)	17 (0-27)	17 (0-19)	17 (0-31)
Body mass index (kg/cm^2), n	597	298	299
Body mass index < 30 kg/cm^2, n (%)	428 (71.7%)	220 (73.8%)	208 (69.6%)
Body mass index ≥ 30 kg/cm^2, n (%)	169 (28.3%)	78 (26.2%)	91 (30.4%)
Waist to hip ratio, median (IQR)	0.86 (0.81-0.91)	0.87 (0.82-0.92)	0.85 (0.80-0.91)
Neck circumference (cm), median (IQR)	37 (36-39)	37 (35-39)	38 (36-40)
Smoking ever in life, n (%)	90 (14.9%)	47 (15.6%)	43 (14.2%)
Family history for CVD, n (%)	32 (5.3%)	14 (4.7%)	18 (6.0%)
Heart rate (bpm), median (IQR)	75 (66-83)	75 (68-83)	75 (65-83)
Blood pressure classification, n	594	297	297
Normal, n (%)	100 (16.8%)	43 (14.5%)	57 (19.2%)
Pre-hypertension[a], n (%)	297 (50.0%)	159 (53.5%)	138 (46.5%)
Hypertension[b] or Tx, n (%)	197 (33.2%)	95 (32.0%)	102 (34.3%)
Serum glucose, n	457	234	223
≥ 7.8mmol/L or Tx, n (%)	38 (8.3%)	18 (7.7%)	20 (9.0%)
< 7.8mmol/L, n (%)	419 (91.7%)	216 (92.3%)	203 (91.0%)
Serum Creatinine	586	296	290
≥ 110 mmol/L, n (%)	102 (17.4%)	58 (19.6%)	44 (15.2%)
< 110 mmol/L, n (%)	484 (82.6%)	238 (80.4%)	246 (84.8%)
eGFR[c]	586	296	290
≥ 90ml/min/1.73m^2, n (%)	440 (75.1%)	212 (71.6%)	228 (78.6%)
60-90ml/min/1.73m^2, n (%)	139 (23.7%)	80 (27.0%)	59 (20.3%)
< 60ml/min/1.73m^2, n (%)	7 (1.2%)	4 (1.4%)	3 (1.1%)
Total cholesterol	587	296	291
≥ 5.17 mmol/L, n (%)	140 (23.9%)	77 (26.0%)	63 (21.6%)
< 5.17 mmol/L, n (%)	447 (76.1%)	219 (74.0%)	228 (78.4%)
HDL cholesterol	587	296	291
≤ 1.04 mmol/L, n (%)	151 (25.7%)	79 (26.7%)	72 (24.7%)
> 1.04 mmol/L, n (%)	436 (74.3%)	217 (73.3%)	219 (75.3%)
LDL cholesterol	587	296	291

≥ 3.0 mmol/L, n (%)	217 (37.0%)	113 (38.2%)	104 (35.7%)
< 3.0 mmol/L, n (%)	370 (63.0%)	183 (61.8%)	187 (64.3%)
Triglycerides	587	296	291
≥ 1.7 mmol/L, n (%)	211 (35.9%)	116 (39.2%)	95 (32.6%)
< 1.7 mmol/L, n (%)	376 (64.1%)	180 (60.8%)	196 (67.4%)

Abbreviations: *P*: p-value; IQR: Interquartile range; bpm: beats per minute; Tx: on medication; eGFR: estimated glomerular filtration rate; HDL: High-density-lipoprotein; LDL: Low-density-lipoprotein

[a]: Systolic blood pressure >120mmHg and/or diastolic blood pressure >80mmHg

[b]: Systolic blood pressure >140mmHg and/or diastolic blood pressure >90mmHg

[c]: Calculated using: 186 x (Creatinine/88.4)$^{-1.154}$ x (Age)$^{-0.203}$ x (0.742 if female) x (1.210 if black African)

1

Table 2. Cardiovascular risk assessments between dayshift only and day-night shift drivers.

	Participants (n=607)	**Day shifts (n=305)**	**Day-night shifts (n=302)**	***P***
Framingham risk score				
10-year Framingham risk percentage, n	585	295	290	**0.05**
10-year Framingham risk percentage, median (IQR)	3.21 (1.66-5.99)	3.52 (1.95-6.23)	2.98 (1.47-5.56)	
Low risk (< 10%), n (%)	518 (88.5%)	265 (89.8%)	253 (87.2%)	
Intermediate risk (10-20%), n (%)	52 (9.0%)	24 (8.1%)	28 (9.7%)	
High risk (> 20%), n (%)	15 (2.5%)	6 (2.0%)	9 (3.1%)	
ASCVD risk score				
10-year ASCVD risk percentage, n	215	111	104	0.94
10-year ASCVD risk percentage, median (IQR)	5.13 (3.62-7.20)	5.16 (3.64-6.66)	5.12 (3.57-7.63)	
Low risk (< 5%), n (%)	103 (47.9)	54 (48.6%)	49 (47.1%)	
Intermediate risk (5-20%), n (%)	107 (49.8%)	55 (49.5%)	52 (50.0%)	
High risk (≥ 20%), n (%)	5 (2.3%)	2 (1.8%)	3 (2.9%)	
Cornell LVH				

LVH based on Criteria > 2.8mV, n (%)	555	14 (4.9%)	9 (3.3%)	0.33
LVH based on Product > 244mVms, n (%)	547	18 (6.5%)	11 (4.1%)	0.21
Solokow-Lyon LVH				
LVH based on Criteria > 3.5mV, n (%)	581	92 (31.7%)	94 (32.3%)	0.88
LVH combined, n (%)	582	105 (36.1%)	104 (35.7%)	0.93
CIMT				
mean CCA IMT (mm), median (IQR)	217	0.54 (0.50-0.70)	0.52 (0.49-0.59)	0.10
max CCA IMT (mm), median (IQR)	217	0.62 (0.57-0.70)	0.60 (0.55-0.66)	0.12
max bulb IMT (mm), median (IQR)	216	0.70 (0.60-0.86)	0.61 (0.51-0.75)	**0.01**
Carotid plaque, n (%)	216	5 (4.1%)	4 (4.3%)	0.93

Abbreviations: P: *p-value; IQR: Interquartile range; ASCVD: Arteriosclerotic cardiovascular disease; LVH: Left ventricular hypertrophy; CIMT: Carotid intima-media thickness; CCA: Common carotid artery; IMT: Intima media thickness*

Abbreviations

AIGHD: Amsterdam Institute for Global Health and Development
ASCVD: Atherosclerotic Cardiovascular Disease
BMI: Body-Mass Index
CCA: Common Carotid Artery
CIMT: Carotid Intima-Media Thickness
CVD: Cardiovascular Disease
ECG: Electrocardiogram
eGFR: Estimated glomerular filtration rate
FRS: Framingham Risk Score
HDL: High-Density-Lipoprotein
IMT: Intima-Media Thickness
IQR: Interquartile Range
LDL: Low-Density-Lipoprotein
LVH: Left Ventricular Hypertrophy

1 NSA: North-Star Alliance

2 OR: Odds Ratio

3 *P*: p-value

4 TG: Triglycerides

5 THS: Trucker Health Survey

6 WRHI: Wits Reproductive Health and HIV Institute

Appendix

Appendix 1: Uni- and multivariable analysis

Linear regression	Log (FRS)			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift	-0.05 (-0.12-0.01)	0.13	-0.02 (-0.06-0.02)	0.18
Age	0.04 (0.04-0.04)	<0.01	0.04 (0.03-0.04)	**<0.01**
Country of origin				
Zimbabwe	-0.07 (-0.14--0.00)	0.04	-0.01 (-0.07-0.04)	0.68
South Africa	Reference			
Zambia	-0.03 (-0.16-0.10)	0.67	0.04 (-0.03-0.15)	0.28
Other	0.05 (-0.06-0.16)	0.38	0.02 (-0.06-0.08)	0.48
Education level				
Primary school or less	0.13 (0.01-0.25)	0.04	-0.09 (-0.10-0.03)	**0.01**
Secondary school	Reference			
Matrix/college/university	-0.02 (-0.09-0.05)	0.65	0.01 (-0.01-0.07)	0.76
Stable relationship	0.31 (0.20-0.41)	<0.01	0.10 (-0.004-0.12)	**< 0.01**

Linear regression	Log (ASCVD)			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift	-0.03 (-0.08-0.02)	0.28	-0.01 (-0.03-0.02)	0.49
Age	0.03 (0.03-0.03)	<0.01	0.03 (0.03-0.03)	**<0.01**
Country of origin				
Zimbabwe	-0.65 (-0.12--0.01)	0.02	0.001 (-0.03-0.03)	0.97
South Africa	Reference			
Zambia	-0.01 (-0.11-0.09)	0.82	0.04 (-0.01-0.09)	0.13
Other	0.04 (-0.05-0.12)	0.37	0.01 (-0.03-0.06)	0.58

Education level				
Primary school or less	0.10 (0.01-0.19)	0.03	-0.08 (-0.12--0.03)	**< 0.01**
Secondary school	Reference			
Matrix/college/university	-0.02 (-0.08-0.03)	0.38	-0.01 (-0.04-0.02)	0.55
Stable relationship	0.22 (0.14-0.30)	<0.01	0.06 (0.02-0.10)	**< 0.01**

Linear regression	**Log (mean CCA-IMT)**			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift	-0.01 (-0.03-0.003)	0.12	-0.003 (-0.02-0.02)	0.74
Age	0.01 (0.004-0.01)	<0.01	0.006 (0.005-0.007)	**<0.01**
Country of origin				
Zimbabwe	-0.01 (-0.04-0.03)	0.74		
South Africa	Reference			
Zambia	-0.02 (-0.07-0.01)	0.24		
Other	-0.04 (-0.05-0.04)	0.83		
Education level				
Primary school or less	0.01 (-0.01-0.04)	0.29		
Secondary school	Reference			
Matrix/college/university	-0.01 (-0.03-0.01)	0.30		
Stable relationship	0.04 (0.01-0.06)	< 0.01	0.008 (-0.02-0.04)	0.61

Binomial logistic regression	**LVH combined**			
	Univariable OR (95% CI)	*P*	Multivariable OR (95% CI)	*P*
Day/night shift	0.99 (0.70-1.38)	0.93	0.94 (0.67-1.33)	0.73
Age	0.98 (0.96-1.00)	0.03	0.99 (0.97-1.00)	0.12
Country of origin				
Zimbabwe	1.34 (0.86-2.08)	0.21		
South Africa	Reference			

Zambia	1.18 (0.55-2.51)	0.67		
Other	1.15 (0.59-2.24)	0.68		
Education level				
Primary school or less	1.36 (0.73-2.52)	0.33		
Secondary school	Reference			
Matrix/college/university	1.21 (0.83-1.74)	0.32		
Stable relationship	0.37 (0.21-0.64)	<0.01	0.40 (0.23-0.70)	**<0.01**

Appendix 2: Sensitivity analysis. Working 2-3 night shifts a week compared to 0-1 night shifts a week (n=228)

Linear regression	**Log (FRS)**			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift (2-3 nights)	-0.03 (-0.10-0.04)	0.34	-0.03 (-0.06-0.01)	0.15
Age	0.04 (0.04-0.04)	<0.01	0.04 (0.04-0.04)	**<0.01**
Country of origin				
Zimbabwe	-0.07 (-0.14--0.00)	0.04	0.01 (-0.04-0.05)	0.75
South Africa	Reference			
Zambia	-0.03 (-0.16-0.10)	0.67	0.04 (-0.04-0.11)	0.31
Other	0.05 (-0.06-0.16)	0.38	0.02 (-0.04-0.09)	0.51
Education level				
Primary school or less	0.13 (0.01-0.25)	0.04	-0.09 (-0.15--0.02)	**<0.01**
Secondary school	Reference			
Matrix/college/university	-0.02 (-0.09-0.05)	0.65	0.01(-0.03-0.04)	0.79
Stable relationship	0.31 (0.20-0.41)	<0.01	0.10 (0.05-0.16)	**<0.01**

Linear regression	**Log (ASCVD)**			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*

Day/night shift (2-3 nights)	-0.01 (-0.07-0.04)	0.63	-0.01 (-0.03-0.02)	0.48
Age	0.03 (0.03-0.03)	<0.01	0.03 (0.03-0.03)	**<0.01**
Country of origin				
Zimbabwe	-0.65 (-0.12--0.01)	0.02	0.00 (-0.03-0.03)	0.99
South Africa	Reference			
Zambia	-0.01 (-0.11-0.09)	0.82	0.04 (-0.01-0.09)	0.14
Other	0.04 (-0.05-0.12)	0.37	0.01 (-0.03-0.06)	0.59
Education level				
Primary school or less	0.10 (0.01-0.19)	0.03	-0.08 (-0.12-0.03)	**< 0.01**
Secondary school	Reference			
Matrix/college/university	-0.02 (-0.08-0.03)	0.38	-0.01 (-0.04-0.02)	0.53
Stable relationship	0.22 (0.14-0.30)	<0.01	0.06 (0.02-0.10)	**< 0.01**

Linear regression	**Log (mean CCA-IMT)**			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift (2-3 nights)	-0.03 (-0.09-0.03)	0.36	-0.004 (-0.04-0.03)	0.82
Age	0.01 (0.004-0.01)	<0.01	0.03 (0.03-0.03)	**<0.01**
Country of origin				
Zimbabwe	-0.01 (-0.04-0.03)	0.74		
South Africa	Reference			
Zambia	-0.02 (-0.07-0.01)	0.24		
Other	-0.04 (-0.05-0.04)	0.83		
Education level				
Primary school or less	0.01 (-0.01-0.04)	0.29		
Secondary school	Reference			
Matrix/college/university	-0.01 (-0.03-0.01)	0.30		
Stable relationship	0.04 (0.01-0.06)	< 0.01	0.05 (-0.01-0.10)	0.09

Binomial logistic regression	**LVH combined**

	Univariable OR (95% CI)	*P*	Multivariable OR (95% CI)	*P*
Day/night shift (2-3 nights)	0.99 (0.68-1.45)	0.91	0.92 (0.69-1.42)	0.79
Age	0.98 (0.96-1.00)	0.03	0.98 (0.97-1.00)	0.11
Country of origin				
Zimbabwe	1.34 (0.86-2.08)	0.21		
South Africa	Reference			
Zambia	1.18 (0.55-2.51)	0.67		
Other	1.15 (0.59-2.24)	0.68		
Education level				
Primary school or less	1.36 (0.73-2.52)	0.33		
Secondary school	Reference			
Matrix/college/university	1.21 (0.83-1.74)	0.32		
Stable relationship	0.37 (0.21-0.64)	<0.01	0.45 (0.25-0.78)	**<0.01**

Appendix 3: Sensitivity analysis. Working ≥4 night shifts a week compared to 0-1 night shifts a week (n=74)

Linear regression	**Log (FRS)**			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift (4 or more nights)	-0.05 (-0.15-0.05)	0.37	0.002 (-0.05-0.05)	0.93
Age	0.04 (0.04-0.04)	<0.01	0.04 (0.04-0.04)	**<0.01**
Country of origin				
Zimbabwe	-0.07 (-0.14--0.00)	0.04	0.01 (-0.04-0.06)	0.70
South Africa	Reference			
Zambia	-0.03 (-0.16-0.10)	0.67	0.04 (-0.03-0.12)	0.28
Other	0.05 (-0.06-0.16)	0.38	0.02 (-0.04-0.09)	0.47
Education level				
Primary school or less	0.13 (0.01-0.25)	0.04	-0.09 (-0.15--0.02)	**<0.01**

Secondary school	Reference			
Matrix/college/university	-0.02 (-0.09-0.05)	0.65	0.01 (-0.03-0.04)	0.73
Stable relationship	0.31 (0.20-0.41)	<0.01	0.10 (0.05-0.16)	**<0.01**

Linear regression	**Log (ASCVD)**			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift (4 or more nights)	-0.04 (-0.11-0.04)	0.35	0.00 (-0.04-0.04)	0.99
Age	0.03 (0.03-0.03)	<0.01	0.03 (0.03-0.03)	**<0.01**
Country of origin				
Zimbabwe	-0.65 (-0.12--0.01)	0.02	0.00 (-0.03-0.03)	0.98
South Africa	Reference			
Zambia	-0.01 (-0.11-0.09)	0.82	0.04 (-0.01-0.09)	0.13
Other	0.04 (-0.05-0.12)	0.37	0.01 (-0.03-0.06)	0.57
Education level				
Primary school or less	0.10 (0.01-0.19)	0.03	-0.07 (-0.12--0.03)	**< 0.01**
Secondary school	Reference			
Matrix/college/university	-0.02 (-0.08-0.03)	0.38	-0.01 (-0.03-0.02)	0.56
Stable relationship	0.22 (0.14-0.30)	<0.01	0.06 (0.02-0.10)	**< 0.01**

Linear regression	**Log (mean CCA-IMT)**			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift (4 or more nights)	-0.05 (-0.14-0.03)	0.21	-0.02 (-0.07-0.03)	0.39
Age	0.01 (0.004-0.01)	<0.01	0.03 (0.03-0.03)	**<0.01**
Country of origin				
Zimbabwe	-0.01 (-0.04-0.03)	0.74		

South Africa	Reference			
Zambia	-0.02 (-0.07-0.01)	0.24		
Other	-0.04 (-0.05-0.04)	0.83		
Education level				
Primary school or less	0.01 (-0.01-0.04)	0.29		
Secondary school	Reference			
Matrix/college/university	-0.01 (-0.03-0.01)	0.30		
Stable relationship	0.04 (0.01-0.06)	< 0.01	0.05 (-0.01-0.10)	0.10

Binomial logistic regression	**LVH combined**			
	Univariable OR (95% CI)	*P*	Multivariable OR (95% CI)	*P*
Day/night shift (4 or more nights)	0.99 (0.81-1.18)	0.95	0.93 (0.73-1.28)	0.79
Age	0.98 (0.96-1.00)	0.03	0.99 (0.98-1.00)	0.10
Country of origin				
Zimbabwe	1.34 (0.86-2.08)	0.21		
South Africa	Reference			
Zambia	1.18 (0.55-2.51)	0.67		
Other	1.15 (0.59-2.24)	0.68		
Education level				
Primary school or less	1.36 (0.73-2.52)	0.33		
Secondary school	Reference			
Matrix/college/university	1.21 (0.83-1.74)	0.32		
Stable relationship	0.37 (0.21-0.64)	<0.01	0.41 (0.28-0.65)	**<0.01**

Appendix 4: Sensitivity analysis. Including only truck drivers working more than 10 years as a truck driver (n=229)

Linear regression	**Log (FRS)**			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*

Day/night shift	0.12 (-0.08-0.33)	0.24	0.06 (-0.06-0.19)	0.32
Age	0.08 (0.07- 0.09)	<0.01	0.08 (0.07-0.08)	**<0.01**
Country of origin				
Zimbabwe	-0.42 (-0.69--0.16)	0.36		
South Africa	Reference			
Zambia	-0.12 (-0.54-0.31)	0.59		
Other	0.15 (-0.51-0.21)	0.41		
Education level				
Primary school or less	0.17 (-0.14-0.47)	0.28		
Secondary school	Reference			
Matrix/college/university	0.18 (-0.05-0.42)	0.24		
Stable relationship	0.59 (0.16-0.1.02)	0.07	0.27 (0.01-0.54)	**0.04**

Linear regression	**Log (ASCVD)**			
	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift	0.04 (-0.03-0.11)	0.27	0.02 (-0.02-0.06)	0.38
Age	0.03 (0.03-0.03)	<0.01	0.03 (0.02-0.03)	**< 0.01**
Country of origin				
Zimbabwe	-0.03 (-0.12--0.01)	0.26		
South Africa	Reference			
Zambia	-0.01 (-0.15-0.12)	0.75		
Other	0.03 (-0.04-0.14)	0.37		
Education level				
Primary school or less	0.08 (0.01-0.11)	0.56		
Secondary school	Reference			
Matrix/college/university	-0.03 (-0.07-0.04)	0.34		
Stable relationship	0.28 (0.19-0.33)	<0.01	0.07 (-0.01-0.15)	0.08

Linear regression	**Log (mean CCA-IMT)**

	Univariable Unstandardized β coefficient (95% CI)	*P*	Multivariable Unstandardized β coefficient (95% CI)	*P*
Day/night shift	-0.01 (-0.01-0.003)	0.15	-0.03 (-0.08-0.001)	0.05
Age	0.01 (0.005-0.01)	<0.01	0.008 (0.005-0.01)	**<0.01**
Country of origin				
Zimbabwe	-0.02 (-0.05-0.04)	0.72		
South Africa	Reference			
Zambia	-0.03 (-0.08-0.02)	0.35		
Other	-0.05 (-0.06-0.05)	0.77		
Education level				
Primary school or less	0.01 (-0.01-0.05)	0.28		
Secondary school	Reference			
Matrix/college/university	-0.01 (-0.04-0.01)	0.38		
Stable relationship	0.04 (0.01-0.05)	< 0.01	0.018 (-0.1-0.13)	0.75

Binomial logistic regression	**LVH combined**			
	Univariable OR (95% CI)	*P*	Multivariable OR (95% CI)	*P*
Day/night shift	0.98 (0.73-1.45)	0.91	0.92 (0.65-1.31)	0.78
Age	0.99 (0.97-1.00)	0.04	0.99 (0.96-1.00)	0.08
Country of origin				
Zimbabwe	1.62 (0.96-2.25)	0.25		
South Africa	Reference			
Zambia	1.21 (0.53-2.66)	0.75		
Other	1.12 (0.54-2.22)	0.58		
Education level				
Primary school or less	1.36 (0.73-2.52)	0.33		
Secondary school	Reference			
Matrix/college/university	1.21 (0.83-1.74)	0.32		
Stable relationship	0.34 (0.23-0.69)	<0.01	0.51 (0.33-0.84)	**<0.01**

Reporting checklist for cross sectional study.

Based on the STROBE cross sectional guidelines.

Instructions to authors

Complete this checklist by entering the page numbers from your manuscript where readers will find each of the items listed below.

Your article may not currently address all the items on the checklist. Please modify your text to include the missing information. If you are certain that an item does not apply, please write "n/a" and provide a short explanation.

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		Reporting Item	Page Number
Title and abstract			
Title	#1a	Indicate the study's design with a commonly used term in the title or the abstract	1
Abstract	#1b	Provide in the abstract an informative and balanced summary of what was done and what was found	3
Introduction			
Background / rationale	#2	Explain the scientific background and rationale for the investigation being reported	5

Objectives	#3	State specific objectives, including any prespecified hypotheses	5
Methods			
Study design	#4	Present key elements of study design early in the paper	6
Setting	#5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Eligibility criteria	#6a	Give the eligibility criteria, and the sources and methods of selection of participants.	6
	#7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	7
Data sources / measurement	#8	For each variable of interest give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group. Give information separately for for exposed and unexposed groups if applicable.	7
Bias	#9	Describe any efforts to address potential sources of bias	8
Study size	#10	Explain how the study size was arrived at	6
Quantitative variables	#11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen, and why	8/9

Statistical methods	#12a	Describe all statistical methods, including those used to control for confounding	9
Statistical methods	#12b	Describe any methods used to examine subgroups and interactions	8/9
Statistical methods	#12c	Explain how missing data were addressed	8
Statistical methods	#12d	If applicable, describe analytical methods taking account of sampling strategy	-
Statistical methods	#12e	Describe any sensitivity analyses	9
Results			
Participants	#13a	Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed. Give information separately for for exposed and unexposed groups if applicable.	9
Participants	#13b	Give reasons for non-participation at each stage	10
Participants	#13c	Consider use of a flow diagram	-
Descriptive data	#14a	Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders. Give information separately for exposed and unexposed groups if applicable.	11

Descriptive data	#14b	Indicate number of participants with missing data for each variable of interest	11
Outcome data	#15	Report numbers of outcome events or summary measures. Give information separately for exposed and unexposed groups if applicable.	11/12
Main results	#16a	Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	11/12
Main results	#16b	Report category boundaries when continuous variables were categorized	10/11/12
Main results	#16c	If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	-
Other analyses	#17	Report other analyses done—e.g., analyses of subgroups and interactions, and sensitivity analyses	13
Discussion			
Key results	#18	Summarise key results with reference to study objectives	13
Limitations	#19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias.	14

Interpretation	#20	Give a cautious overall interpretation considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence.	13/14
Generalisability	#21	Discuss the generalisability (external validity) of the study results	14
Other Information			
Funding	#22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15