BMJ Open

Social Epidemiology of Hypertension in Buffalo City Metropolitan Municipality (BCMM): Determinants of Prevalence, Awareness, Treatment and Control among South African Adults.

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2016-014349
Article Type:	Research
Date Submitted by the Author:	18-Sep-2016
Complete List of Authors:	OWOLABI, EYITAYO ; University of Fort Hare Department of Nursing Sciences, Department of Nursing Sciences Goon, Daniel ; University of Fort Hare Department of Nursing Sciences, Department of Nursing Sciences ADENIYI, OLADELE VINCENT; Cecilia Makiwane Hospital, DEPARTMENT OF FAMILY MEDICINE SEEKOE, EUNICE; University of Fort Hare Department of Nursing Sciences, Department of Nursing Sciences
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Cardiovascular medicine, General practice / Family practice, Global health, Public health, Patient-centred medicine
Keywords:	Hypertension < CARDIOLOGY, General diabetes < DIABETES & ENDOCRINOLOGY, Clinical governance < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PRIMARY CARE, PUBLIC HEALTH

Social Epidemiology of Hypertension in Buffalo City Metropolitan Municipality (BCMM): Determinants of Prevalence, Awareness, Treatment and Control among South African Adults

***Eyitayo Omolara Owolabi[1], Daniel Ter Goon[2], *Oladele Vincent Adeniyi[3], Eunice Seekoe[4]**

1. *Department of Nursing Science, Faculty of Health Sciences, University of Fort Hare, East London, South Africa. Email: owolabiomolara101@gmail.com*
2. *Department of Nursing Science, Faculty of Health Sciences, University of Fort Hare, East London, South Africa. Email: dgoon@ufh.ac.za; daniel.goon2013@yahoo.com.*
3. *Department of Family Medicine, Faculty of Health Sciences, Walter Sisulu University/ Cecilia Makiwane Hospital, East London Hospital Complex, East London, South Africa. Email: vincoladele@gmail.com.*
4. *Department of Nursing Science, Faculty of Health Sciences, University of Fort Hare, East London, South Africa. Email: eseekoe@ufh.ac.za.*

***Corresponding Author:**

Eyitayo Omolara Owolabi

Department of Nursing Science, Faculty of Health Sciences,

University of Fort Hare, East London, 5200

South Africa. Email: 201502792@ufh.ac.za; owolabiomolara101@gmail.com

Tel: +27730719622

Keywords: Blood Pressure Control, Diabetes mellitus, Hypertension, Obesity, South Africa

Word count: 3597

5 tables and 1 figure

Abstract

Objectives: Epidemiological data on prevalence, awareness, treatment and control of blood pressure are scarce in Buffalo City Metropolitan Municipality (BCMM), South Africa is scarce. We therefore examined hypertension prevalence, awareness, treatment, control and their determinants among adults attending health facilities in BCMM.

Design: A cross-sectional analytical study.

Settings: Three largest out-patient clinics in BCMM.

Participants: Ambulatory adults (18 years and above) attending the study settings during the study period (n=998).

Primary outcome measure: Prevalence of hypertension (systolic BP of ≥140mmHg and/or a diastolic BP of ≥ 90mmHg or current medication for hypertension), awareness (prior diagnosis of hypertension), treatment and control (Eight Joint National Committee Criteria of blood pressure < 140/90 mmHg).

Secondary outcome measure: Associated factors of hypertension, unawareness and uncontrolled hypertension.

Results: Of the 998 participants included, the prevalence of hypertension was 49.2%. Hypertension unawareness was reported by 152 participants (23.1%) with significant gender difference (p=0.005). Higher monthly income, single status, age less than 45 years, unemployment, current cigarette smoking, alcohol usage, absence of diabetes and non-obese were significantly associated (p<0.05) with hypertension unawareness.

Of the participants who were aware (n=339), nearly all (93.1%, n=311) were on anti-hypertensive medications and only 131 participants (42.1%) achieved blood pressure treatment target. In the multivariate logistic regression model analysis, aging (95%CI 1.9 to 4.4), being married (95%CI 1.0 to 2.0), male sex (95%CI 1.2 to 2.3), concomitant diabetes (95%CI 1.9 to 3.9), lower monthly income (95%CI 1.2 to 2.2), being unemployed (95%CI 1.0 to 1.9) and central obesity (95%CI 1.5 to 2.8) were the significant and independent determinants of prevalent hypertension.

Conclusion: Prevalence and awareness of hypertension was high in the study population. However, the sub-optimal control of blood pressure among treated individuals as well as the significant cardiovascular risk factors warrants attention of health authorities of BCMM and the country.

Strengths and limitations of the study

- **Large sample size of participants.**

- **First epidemiological data on hypertension prevalence, awareness, treatment and control in BCMM.**
- **Survey was conducted in the three largest out-patient clinics.**
- **Findings should be treated with caution in view of the cross-sectional design and convenience sampling.**

Introduction

Cardiovascular diseases (CVD) are the leading cause of death (17.3 million deaths) worldwide with a steep increase, especially in the developing countries, with 80% death toll prevalence.[1] Cardiovascular diseases have been predicted to account for about 23.6 million deaths by 2030.[2] Hypertension is the most important modifiable risk factor for cardiovascular diseases and an independent risk factor for mortality worldwide [3-6] and is been described as a silent killer and a dangerous disease due to its asymptomatic nature among the sufferers.[7] About nine million people die from hypertension annually.[8]

The prevalence of hypertension in Africa has been reported in several studies.[9-12] Hypertension usually considered a disease of affluence, is now prevalent among the poor.[13] In 2012, one in three adults were reported to be hypertensive with the highest prevalence recorded in Africa (50%).[14] South Africa is facing a serious burden from hypertension.[15] More than 6.2 million South Africans are hypertensive; 3.2 million have blood pressure higher than 160/90mmHg and about 53 men and 78 women die daily from the effect of hypertension.[16] Considering the pace of economic growth in South Africa, a further increase in the prevalence of hypertension is expected if drastic actions are not implemented in the country.[17,18] Treatment and control of hypertension are associated with reduced incidence of complications, such as stroke, coronary heart disease and kidney disease.[19-21]

While the majority of individuals with hypertension remain undiagnosed, there is evidence supporting the sub-optimal control of blood pressure among individuals in care for hypertension in South Africa.[22-25] Many reasons have been advanced for the sub-optimal treatment outcomes, such as socio-economic and behavioural factors and health system factors.[22,26-28]

In sub-Saharan Africa, the burden of hypertension is worsened by unreliable epidemiologic data, under-diagnosis, poor treatment and uncontrolled hypertension.[29-31] Epidemiologic data helps to inform public health policies for the prevention and control of hypertension burden.[32] Likewise, prevention strategies, increased awareness, prompt detection, adequate treatment and control of blood pressure are basic requirements for a comprehensive approach for the reduction of hypertension, its complications and ultimately, the associated morbidity and mortality.[33]

There is paucity of data on the prevalence, awareness and control of hypertension in Eastern Cape, an understudied province in South Africa. Such a vital epidemiological data will inform policies on non-communicable diseases, resource distribution and crafting effective interventions. Therefore, this study bridges the gap by determining the prevalence and associated factors of hypertension, awareness and controlled hypertension among adults attending the three largest out-patient clinics in the Buffalo City Municipality, Eastern Cape, South Africa.

Methods

Study area and design

This study analysed data from the Buffalo City Metropolitan Municipality (BCMM) Non-Communicable Disease Surveillance study. Briefly, we selected the three largest out-patient clinics serving the residents of Buffalo City Municipality, South Africa. These clinics provide primary health care services for the 755,200 residents of Buffalo City Municipality of Eastern Cape Province.[34] The family medicine outpatient clinic of Cecilia Makiwane hospital and Nontyatyambo community health centre provide primary health care services to the predominant black South African residents of Mdantsane Township, a semi-urban community of Eastern Cape and Empilweni-Gompo community health centre situated in Duncan Village, a suburban community of East London.

Participants and Sample size

The sample size of the Buffalo City Metropolitan Municipality (BCMM) Non-Communicable Disease Surveillance study was based on the estimated proportion of individuals with

hypertension in the population. The appropriate sample size was estimated using the following formula:

$$N = (Z_{1-\alpha})^2 * (P(1 - P))/ D^2$$

Where Z is the confidence level, P is the expected proportion of individuals with hypertension, and D is the margin of error. P was set at 0.40 and D at 0.05. The calculation was performed at the 95% confidence level. The required sample size per study site was 369 participants and a total of 1107 participants were included in the study. All ambulatory individuals (patients and their family members) who fulfilled the inclusion criteria and attending the study settings during the period of study were recruited into the study. All participants with abnormal findings agreed to be evaluated by the clinicians at the study settings. This study was conducted in April-May, 2016.

Eligibility criteria

Participants were included if age ≥ 18 years, attending the out-patient clinics of the selected hospital and community health centres, willing to participate and had fasted in the preceding eight hours prior to recruitment into the study. Exclusion criteria include acutely ill, psychotic, debilitated, pregnant or handicapped in any form such that obtaining anthropometric measurement would be difficult. Consecutive sample of 1107 participants took part in the study.

Study instrument

The participants were interviewed using the previously validated WHO STEPwise questionnaire[35] which comprises three major items; demographic and behavioural data, and measurements.

Ethical approval

Ethical approval was obtained in accordance with Helsinki II Declaration from the University of Fort Hare Research Ethics Committee and the Eastern Cape Department of Health. The management of the sub-district department of health as well as the head of the respective health facilities gave permission prior to data collection. All participants provided written informed consent to participate in this study.

Data collection procedure

Data were obtained by personal interview on demographic and behavioural characteristics and measurements of blood pressure, blood glucose and anthropometric parameters. Demographic variables included items on sex, age, marital status, level of education, employment status and average monthly income earning. The socioeconomic factors were measured by assessing the average monthly income, level of education and employment status. Participants were categorised as low income earners if they earned R2000 or less per month and middle income earners if they earned more than R2000. Level of education was obtained by self-reporting of the highest grade level attained in school and were categorised as having no formal education, primary (grade 1-7), secondary (grade 8-12) or tertiary (post-secondary). Participants were defined as unemployed if they reported that they were not employed in both formal and informal sectors.

The following behavioural variables were obtained by self-reporting; cigarrete smoking, alcohol use, physical activity, and fruit and vegetables consumption patterns. Participants were questioned on their servings of fruit and vegetables daily. The smoking categories include; primary smokers (smoking directly) or secondary smokers (if living with a smoker) or non-smoker. Physical activity level of participants were obtained by self-reporting and categorised based on their engagement in moderate (yes/no) or vigorous intensity (yes/no) exercise leading to an increase in heart rate and respiratory rate such as gardening.

Measurements

Blood pressure (systolic and diastolic) was measured in accordance with standard protocols[36] with a validated Microlife BP A100 Plus model. Hypertension was defined as average of two systolic blood pressure of $\geq$ 140mmHg and diastolic of $\geq$ 90mmHg in accordance with the Eight Joint National Committee (JNC 8). Participants who reported being informed of their hypertensive status by health professional(s) were considered aware. Uncontrolled hypertension among those on treatment with at least one or more anti-hypertensive medications was defined as systolic blood pressure greater than or equal to 140mmHg and diastolic blood pressure greater than or equal to 90mmHg in accordance with the Eight Joint National Committee Report (JNC 8). Fasting blood glucose of each participant was measured with a validated ACCU-CHEK glucose monitoring apparatus in fasting state. Participants were diagnosed of having diabetes if their fasting blood glucose equal or greater than 7.0 mmol/L or current medications for diabetes and they were defined as having pre-diabetes if the fasting blood glucose falls between 6.1-6.9 mmol/L.[37]

Body weight was measured in light clothes to the nearest 0.01kg in the standing position using a Soehnle Scale (Soenle-Waagen Gmbh Co., Muurhardt, Germany) and height was measured to the nearest 0.1m by stadiometer in standing position with closed feet (without shoes), holding their breath in full inspiration and Frankfurt line of vision.[38] Body mass index (BMI) was calculated as weight in kg divided by height in square metres (kg/m^2). BMI was categorized in accordance with WHO[39] as <18.5kg/m^2, 18.5-24.9kg/m^2, 25.5-29.9kg/m^2 and >30.0kg/m^2 as underweight, normal, overweight and obese, respectively.

Statistical analysis

Data were expressed as mean values ± standard deviations (SD) for continuous variables. Counts (frequencies=n) and proportions (%) were reported for categorical variables. Percentages were compared using Chi-square test. The bivariate and multivariate logistic regression were used to identify the significant associated factors of hypertension and their 95% confidence interval (95% CI). The logistic regression was also adjusted for confounding factors. Statistical analyses were performed with the Statistical Package for Social Science (SPSS) version 21 for windows (SPSS Inc., Chicago, IL, USA) and p-value < 0.05 were considered statistically significant.

Results

We excluded 109 participants with incomplete data. Of the 988 included in our analysis; 321 were males and 677 were females. More than half of the respondents; 56.5% and 60.2% were between the ages of 18 and 45 years for male and female, respectively. With respect to income level; 69.4% and 80.9% of men and women, respectively either had no source of income or earned less than 2000 rand. Table 1 provides the descriptive characteristics of the participants.

Table 1 Demographic characteristics of the participants by sex

Variables	Male (n=321) n(%)	Female (n=677) n(%)	Total (n=998) n(%)	p-value
Age group (years)				
18-25	40(12.5)	143(21.1)	183(18.3)	
26-35	74(23.1)	149(22.0)	223(22.3)	
36-45	67(20.9)	116(17.1)	183(18.3)	0.009
46-55	57(17.8)	110(16.2)	167(16.7)	
56-65	41(12.8)	99(14.6)	140(14.0)	
≥66	42(14.1)	60(8.9)	102(10.2)	
Level of education				
No formal schooling	62(19.3)	84(12.4)	146(14.6)	
Grade 1-7	57(17.8)	99(14.6)	156(15.6)	0.008
Grade 8-12	17(53.3)	409(60.4)	580(58.1)	
Tertiary	31(9.7)	85(12.6)	116(11.6)	
Monthly income (Rands)				
No income	134(41.7)	300(44.3)	445(44.6)	
R150-2000	89(27.7)	248(36.6)	326(32.7)	0.000
R2001-5000	74(23.1)	100(14.8)	174(17.4)	
R5001and above	24(7.5)	29(4.3	53(5.3)	
Marital status				
Single	193(60.3)	444(65.6)	637(63.9)	
Married	115(35.9)	185(27.3)	300(30.1)	
Separated	1(0.3)	5(0.7)	6(0.6)	0.002
Divorced	9(2.8)	13(1.9)	22(2.2)	
Widowed	2(0.6)	30(4.4)	32(3.2)	
Racial group				
Black	313(97.5)	666(98.4)	979(98.1)	
Coloured	8(2.8)	9(1.3)	17(1.7)	0.26
White	0(0.0)	2(0.3)	2(0.2)	
Type of employment				
Government employee	30(9.3)	33(4.9)	63(6.3)	
Non-government employment	98(30.5)	133(19.7)	231(23.2)	
Self-employment	30(9.3)	32(4.7)	62(6.2)	
Students	19(5.9)	80(11.8)	99(9.9)	0.00
Unemployed	115(24.2)	361(53.4)	476(47.7)	
Retired	29(9.0)	37(5.5)	66(6.6)	

Prevalence, Awareness and Treatment of Hypertension

Of the 998 participants, 49.2% (n=491) were diagnosed of hypertension. Awareness of prior diagnosis of hypertension was reported by 339 participants (69.1% of those hypertensive). Among those aware of hypertension diagnosis, nearly all (91.7%, n=311) were on hypertensive treatment. Treatment to target blood pressure occurred in 42.1% (n=131) among the treated individuals.

Factors associated with hypertension

In bivariate analysis (Table 2), the following risk factors; aging, male sex, lower level of education (below grade 8), being married, unemployed, lower income level, never drank alcohol, sedentary lifestyle, both central and overall obesity were significantly associated with hypertension. Body mass index and age demonstrated positive linear association with prevalent hypertension.

Table 2 Bivariate analysis showing the associated risk factors for hypertension

Variables	Hypertensive	Normal BP	RR	95% CI	p-value
Sex					
Male	175(54.5)	146(45.5)	-	-	0.000
Female	316(46.7)	361(53.3)			
Age (years)					
≤25	35(19.1)	148(80.9)	-	-	0.000
26-35	66(29.6)	157(70.4)			
36-45	72(39.3)	111(60.7)			
46-55	133(67.7)	54(32.3)			
56-65	117(83.6)	23(16.4)			
≥66	88(86.3)	14(13.7)			
Level of education					
No formal schooling	77(52.7)	69(47.3)	0.4	0.3-0.5	0.000
Grade 1 to 7	118(75.6)	38(24.4)			
Grade 8 to 12	250(43.1)	330(56.9)			
Tertiary	46(39.7)	70(60.3)			
Marital status					
Never married	251(39.4)	386(60.6)	-	-	0.000
Married	211(64.3)	117(35.7)			
Employment					
Government employee	33(52.4)	30(47.6)	-	-	0.000
Non-government employee	104(45.0)	127(55.0)			
Self-employed	29(46.8)	33(53.2)			
Student	18(18.2)	81(81.8)			
Unemployed	252(52.9)	224(47.1)			
Retired	54(81.8)	12(18.2)			
Monthly income					
R2000	222(62.2)	135(37.8)	1.9	1.4-2.7	0.000
≥R2001	105(46.3)	122(53.7)			
Ever drink alcohol					
Yes	131(41.1)	188(58.9)	0.6	0.5-0.8	0.000
No	359(53.7)	310(46.3)			
Moderate intensity physical activity					
Yes	256(45.6)	305(54.4)	0.7	0.6-0.9	0.006
No	234(53.8)	201(46.2)			
Vigorous intensity physical activity					
Yes	58(37.9)	95(62.1)	0.6	0.4-0.8	0.002
No	433(51.5)	412(48.8)			
Body mass index (kg/m^2)					
Underweight	12(37.5)	20(62.5)	-	-	0.000
Normal	89(33.0)	181(67.0)			
Overweight	106(45.3)	128(54.7)			
Stage 1 obesity	114(55.6)	91(44.4)			
Stage 2 obesity	84(60.9)	54(39.1)			
Stage 3 obesity	76(72.4)	29(27.6)			
Central obesity derived from waist-to-hip ratio					
Yes	268(56.8)	204(43.2)	0.6	0.4-0.7	0.000
No	221(42.3)	301(57.7)			

WC derived central obesity					
Obese	355(54.7)	294(45.3)	2.4	1.9-3.1	0.000
Not obese	135(38.9)	212(61.1)			

RR= Relative risk; CI= Confidence interval

In the multivariate logistic regression model analysis (Table 3), aging, being married, male sex, concomitant diabetes mellitus, lower income level, being unemployed and central obesity were the significant and independent determinants of prevalent hypertension.

Table 3 Multivariate logistic regression analysis showing the predictors of hypertension

Variables	Beta	Wald	AOR (95% CI)	p-value
Age				
≤26 (Reference)				
Above 26	1.06	23.78	2.9(1.9-4.4)	0.005
Marital status				
Never married (Reference)				
Ever married	0.39	5.89	1.5(1.0-2.0)	0.015
Sex				
Female (Reference)				
Male	0.51	9.83	1.7(1.2-2.3)	0.000
Diabetes mellitus				
No (Reference)				
Yes	1.01	31.6	2.7(1.9-3.9)	0.000
Monthly income				
Middle-income >2000 (Reference)				
Low income ≤ 2000	0.49	9.48	1.6(1.2-2.2)	0.002
Employment				
Employed (Reference)				
Unemployed	0.33	4.01	1.4(1.0-1.9)	0.045
Central obesity derived from waist circumference				
No (Reference)				
Yes	0.63	10.0	2.1(1.5-2.8)	0.000

AOR=Adjusted odd ratios; CI= Confidence interval

Factors associated with hypertension awareness and control

Hypertension unawareness occurred in 152 participants with significant difference by sex (p=0.005). The following factors; male sex, lower ages, higher level of education, single status, current employment status, higher income earners, current smokers, alcohol users, non-diabetic and non-obese individuals were associated with hypertension unawareness in the study (Table 4).

Table 4 Bivariate analysis showing the associated factors of hypertension unawareness

Variables	Aware	Unaware	RR	95% CI	p-value
Sex					
Male	108(61.7)	67(38.3)	0.6	0.4-0.9	0.005
Female	232(73.4)	84(26.6)			
Age (years)					
<45	79(23.2.)	95(54.6)	-	0.1-0.3	0.000
>45	261(82.3)	56(17.7)			
Level of education					
No formal schooling	57(73.1)	21(26.9)	-	-	0.002
Grade 1-7	93(78.8)	25(21.1)			
Grade 8-12	168(67.2)	82(32.8)			
Tertiary	22(48.9)	23(51.1)			
Marital status					
Never married	152(60.6)	99(39.4)			
Married	161(76.3)	50(23.7)	0.5	0.3-0.7	0.000
Employment status					
Employed	99(59.3)	68(40.7)	0.5	0.3-0.7	0.000
Unemployed	241(74.4)	83(25.6)			
Monthly income (Rands)					
<R2000	276(71.7)	109(28.3)	1.7	1.1-2.6	0.018
>R2000	64(60.4)	42(39.6)			
Current smokers					
Yes	33(50.0)	33(50.0)	0.4	0.2-0.7	0.000
No	307(72.2)	118(27.8)			
Ever drink alcohol					
Yes	67(50.8)	65(49.2)	0.3	0.2-0.5	0.000
No	272(76.2)	85(23.8)			
Diabetes mellitus					
Yes	114(85.1)	20(14.9)	0.3	0.2-0.5	0.000
No	226(63.3)	131(36.7)			
Obesity					
Yes	260(73.4)	94(26.6)	2.5	1.5-3.2	0.001
No	79(58.1)	57(41.9)			

RR= Relative risk; CI= Confidence interval

Among the participants on treatment for hypertension (n=311); only monthly income (less than R2000) and concomitant diabetes mellitus (marginally) were significantly associated with uncontrolled hypertension (Table 5).

Table 5 Bivariate analysis showing the factors associated with hypertension control

Variables	Controlled HTN	Uncontrolled HTN	RR	95% CI	p-value
Sex					
Male	34(35.4)	62(64.4)	0.8	0.5-1.3	0.262
Female	86(40.0)	129(60.0)			
Age (years)					
<45	31(47.7)	34(52.3)	1.6	0.9-2.8	0.061
>45	89(36.2)	157(63.8)			
Level of education					
No formal schooling	11(52.4)	10(47.6)	-	-	0.209
Grade 1-7	18(35.3)	33(64.7)			
Grade 8-12	56(35.4)	102(64.6)			
Tertiary	11(61.1)	7(38.6)			
Marital status					
Never married	56(42.4)	76(57.6)	1.5	1.0-2.4	0.072
Married	51(33.3)	102(66.7)			
Employment status					
Employed	36(41.4)	51(58.6)	1.2	0.7-2.0	0.0307
Unemployed	84(37.5)	40(62.5)			
Monthly income (Rands)					
<R2000	49(29.9)	115(70.1)	0.5	0.3-1.0	0.021
>R2000	27(45.8)	32(54.2)			
Current smokers					
Yes	11(39.3)	17(60.7)	1.0	0.5-2.3	0.544
No	109(38.5)	174(61.5)			
Ever drink alcohol					
Yes	18(32.7)	37(67.3)	0.7	0.4-1.3	0.204
No	102(39.8)	154(60.2)			
Diabetes mellitus					
Yes	87(56.9)	66(43.1)	0.7	0.4-1.1	0.052
No	105(66.5)	53(33.5)			
Obesity					
Yes	76(36.8)	125(62.2)	0.9	0.6-1.5	0.398
No	44(40.0)	66(60.0)			

RR= Relative risk; CI= Confidence interval; HTN= Hypertension

Discussion

To the best knowledge of the authors, this is the first paper addressing the epidemiological gaps on the prevalence, awareness, treatment and control of hypertension in the Buffalo City Metropolitan Municipality (BCMM). We found a high prevalence of hypertension (49.2%) in our study population. There seems to be an upward trend in the prevalence of hypertension in the country which is rather unsurprising due to the rapid urbanization and its consequent effect on population health. Our result is higher than Day et al. [23] study which reported 40% prevalence of hypertension among South African adults in 2010. A lower prevalence of hypertension (38.9%) was reported by Peer et al.[25] among black urban South Africans in Cape Town. A nationally representative house-hold survey in South Africa reported a prevalence range of 9% in Limpopo Province to 22.3% in Northern Cape Province.[34] Highest

prevalence of hypertension (12.4%) was found among the black South African population. Weimann et al.[40] estimated a higher prevalence of 37% and 52% in Eastern Cape and Northwest Provinces. The higher prevalence of 49.2% found among our sample is comparable to Northwest Province of 52%, but higher than that of Eastern Cape Province reported by Weimann et al.[40] Our result was obtained from the primary health care setting and thus, may have slightly overestimated the prevalence in the population.

There is a wide variation in the prevalence of hypertension across the sub-Saharan Africa; from 23% among Zambian and Angola adults to 26% in adults in four selected sub-Saharan African countries.[10-12,41] Akpan et al. [9] reported prevalence of 48.3% among some rural dwelling adults in Eastern part of Nigeria, while 44.7% prevalence was documented among Ghanaian adults residing in a rural setting. Similar trend of increasing prevalence of hypertension have been reported worldwide; Chow et al.[30] found a prevalence of 40.8% among rural and urban dwellers in some selected high income countries (Canada, Sweden, United Arab Emirates), middle income countries (Argentina, Brazil, Chile, Poland, Turkey, Malaysia, South Africa, China, Colombia, Iran) and low income countries (Bangladesh, India, Pakistan and Zimbabwe). Higher prevalence was reported among some other developing countries with prevalence ranging from 50.7- 79.8% among adults living in urban areas of India, Latin America and China.[42,43] Our finding further supports the epidemiological shift of non-communicable diseases to developing nations.[13,44]

Although a thorough comparison of various studies cannot be done as a result of differences in the definitions, methodology and populations used by various studies. However, the findings from this study indicate that South Africa is already at the fore front of the epidemiologic transition being complicated by advancement in technology attributed to urbanization and westernization. These are both the driving forces of the increasing burden of non-communicable disease risk factors of which hypertension is predominant. This is linked to adoption of unhealthy lifestyle behaviours and poor dietary practices as well as poor engagement in physical activity leading to obesity, and ultimately, cardiovascular risk factors like hypertension. Our findings signal a looming burden of non-communicable disease among the study participants if urgent actions are not taken.

We found aging, male sex, being married, unemployment status, poverty, sedentary lifestyles, obesity and diabetes mellitus as the important determinants of prevalent hypertension in the

study population. Several other studies have also established a link between these risk factors. Pires et al.[12] affirmed that increasing age, lower level of education and increasing weight were associated with hypertension. Additionally, Guwatudde et al.[11] found diabetes to be significantly associated with hypertension. Increasing age is often associated with changes in the body systems including the cardiovascular system such as the heart and arteries. Old people suffer a great deal of cardiovascular risk factors, especially hypertension.[45]

We found higher prevalence of hypertension in individuals with lower level of education (below grade 8). These individuals are most likely unemployed and earned less than R2000. Although, the association between the level of education and health is rather complex; it can be assumed that the more educated an individual is, the more knowledgeable he will be about his health. Whether this assumption is true in our study population is rather speculative. Cutler and Lleras-Muney[46] reported that education increases knowledge. Educated individuals are more likely to be receptive to new developments including newly approved drugs and often compliant with drug use.[47,48] Our study participants with hypertension were poor and unemployed. Their poor socio-economic status also limit their access to healthy food and thus, increase consumption of readily available cheap foods which are contributing to the burden of non-communicable risk factors such as obesity and hypertension. We found higher prevalence of hypertension among men. Female hormonal effect is believed to be protective[49] and since the majority of the women in this study were below 50 years, this could be a plausible reason for our findings. Also, obesity, work stress, physical inactivity, alcohol intake and salt intake have been reported to be high in men thus, resulting in higher odds of developing hypertension.[50]

There is a substantial intersection between hypertension and diabetes because of the shared metabolic pathway and risk factors.[51-53] Hypertension is always found in more than half of individuals with type 2 diabetes and the chance of developing hypertension among persons with type 2 diabetes is more than double .[54] Also, as shown by Murphy et al. and Bromfield & Munter,[55,56] there is a recognized link between hypertension, obesity, smoking, harmful use of alcohol and physical inactivity and a larger percentage of hypertension burden is attributed to these factors. The relationship between hypertension and obesity has long been established. Obesity increases the chance of developing hypertension and increases the risk of developing cardiovascular complications.[57,58] As reported by Pandey et al, ,[59] smoking increases the

prevalence of hypertension.[53] Physical inactivity is a precursor to obesity and hypertension. Physical inactivity is responsible for 20% of hypertension cases.[60]

This present study further illustrates that the majority (69.1%) of the hypertensive patients were aware of their status, and of these, almost all (91.7%) were already on treatment with only 38.6% achieving control. This awareness rate is higher than the 24% awareness rate reported among South Asian adults.[61]There is a wide variation of hypertension awareness across African countries with rates ranging from between 8% in Nigeria to 81% among the elderly individuals in Tunisia.[62]

Despite the scientific successes in anti-hypertensive drug discoveries, achieving treatment targets remain a serious challenge. Although, nearly all of the participants with prior diagnosis were already receiving treatment for hypertension which is a commendable effort, however, only 38.6% achieved treatment targets. This is somewhat better than previous studies conducted in Mthatha, South Africa and Zimbabwe, 25.5% and 32.8%, respectively.[22,31] It is also comparable to the rate of control of hypertension (36.4%) reported by Day et al.[23] in a household survey conducted among South African adults in 2010. Generally, hypertension control has been reported to be sub-optimal in Africa, ranging from 2.6% in Kenya to 42.2% in Ethiopia.[62-64]

We observed that men, those earning more than R2000, age less than 45 years, employed, cigarette smokers and alcohol users had higher rates of hypertension unawareness. Men have been reported to have higher odds of developing hypertension and the high rate of unawareness among them is not surprising. Females have been recognised to seek healthcare better than men.[65] Traditional gender roles in Africa account for underutilisation of health facilities among men; men are the breadwinners and are perceived as healthy.[66,67] Hence, they rarely seek health facilities for screening purposes unless when they are sick. Hypertension is largely asymptomatic and as such, an affected individual will rarely seek healthcare. Our findings have serious public health consequences; due to the clustering of cardiovascular diseases among the individuals with hypertension unawareness. Younger individuals are unlikely to visit health facilities without any major sickness. Hence, the high rate of unawareness in those younger than 45 years. Beside, this cohort of individuals are pre-occupied by their jobs. Older individuals tend to have multi-morbidity and as such, would have had several opportunities to be screened for non-communicable diseases. Alcohol and

nicotine dependence may explain our findings of high unawareness among alcohol users and current cigarrete smokers, respectively.

We found a high rate of uncontrolled hypertension (62.4%) in our study participants. Though, several factors have been implicated for the control of hypertension in Africa, which are generally related to the deficiencies in the healthcare system, non-adherence to medication regimen by the patients as well as the physicians' inertia to optimise treatment of hypertension.[22,62] Several other studies also documented unavailability of anti-hypertensive drugs as well as non-adherence to clinic visits by the patients as a result of lack of transportation means and time.[12,68,69] Poor treatment outcomes in Africa has been documented extensively.[13,31,62,70,71] In comparison, higher levels of control (64.8% and 66%) of hypertension were reported in USA and Canada, respectively.[72,73] This is not a surprise as management of hypertension is costly due to its chronic nature and developed countries have been recording successes in the reduction of the burden related to hypertension and other non-communicable diseases.[74]

Also, participants who had diabetes mellitus were found to have lower rate of controlled hypertension. Multi-morbidity with significant risks of poly-pharmacy are some of the reasons for the poor control of blood pressure in those with concomitant diabetes. Previous report from similar setting by Adeniyi et al.[22] found poor control of blood pressure among individuals with concomitant diabetes. Poverty was associated with poor blood pressure control among our study participants already on treatment for hypertension. Poor treatment outcomes among individuals with poor earnings is not surprising. This can be linked to poor access despite the availability of medications at the health facility, some of our patients regularly miss appointments and fail to pick-up medications. Also, the patients are incapable to purchase essential drugs for hypertension (out of pocket) and as well as eat healthy foods that promote health, which are expensive and cannot be afforded by the low-income earning participants.[75]

Strength and Limitations

The limitations of the study cannot be ignored. Firstly, this is a cross-sectional study hence, causality cannot be ascribed to the determinants. Our findings should be interpreted with caution in view of the convenience sampling of the participants at the primary health care facilities. We also did not obtain information on the hypertensive medications and as such,

could not gain full understanding of the uncontrolled hypertension in our study participants. Notwithstanding these limitations, the findings of the study provide useful epidemiological data in view of the large sample size, largest out-patient clinics selected and the understudied setting.

CONCLUSION

Findings of high prevalence and sub-optimal blood pressure control of hypertension requires urgent attention of health authorities of Buffalo City Metropolitan Municipality. Also, the clustering of cardiovascular risk factors in individuals with hypertension suggests that integrated strategy addressing all the non-communicable diseases will be needed to mitigate the scourge of the looming epidemic. Re-engineering of the primary health care in BCMM will be crucial to dealing with the burden of non-communicable diseases in the region.

Consent for publication

All authors approved the submission of this final draft towards publication in a peer review journal.

Availability of data and materials

Data from this study will be made available on request.

Competing interests

The authors declare no conflict of interest.

Funding

EOO received master's study grants from the National Research Foundation and the Health and Welfare Sector Education and Training Authority, South Africa towards the implementation of the project.

Authors' Contributions

EOO, DTG and OVA conceptualised, designed and drafted the paper. ES participated in data collection and gave intellectual contribution into the manuscript. All authors read and approved the final manuscript.

Acknowledgements

The authors are grateful to the management and the nursing staff of the three health facilities for their support towards the successful implementation of the project.

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FIGURE

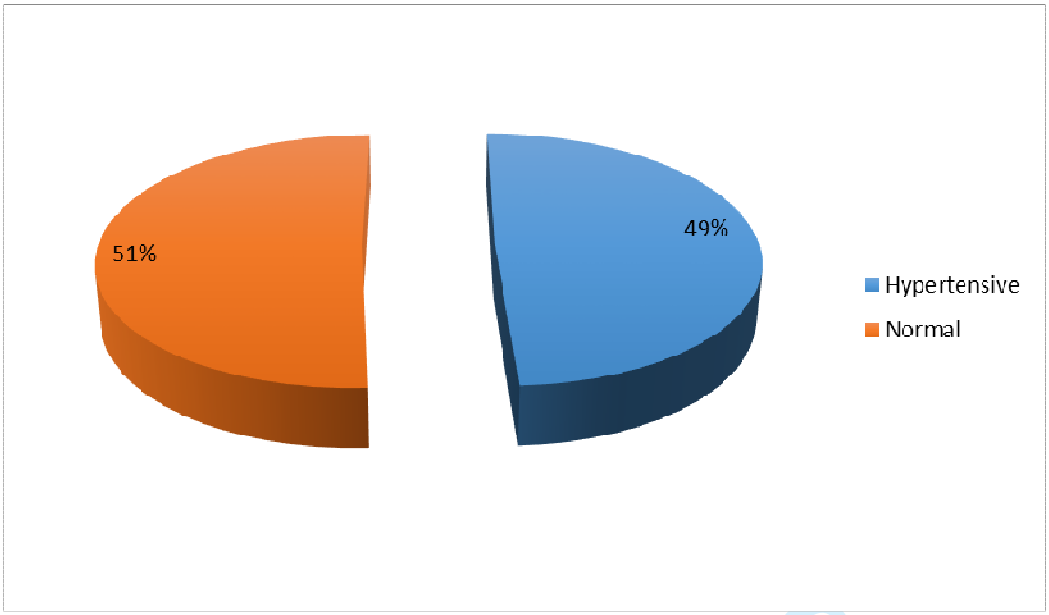

Figure 1 Prevalence of blood pressure

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract **Pg 1 & 2**	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction - Pg 3		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported
Objectives	3	State specific objectives, including any prespecified hypotheses
Methods – Pg 4		
Study design	4	Present key elements of study design early in the paper
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
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
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses

Continued on next page

Results – Pg 7		
Participants	13*	(a) 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
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) 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
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion – Pg 12		
Key results	18	Summarise key results with reference to study objectives
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
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	Discuss the generalisability (external validity) of the study results
Other information – Pg 17		
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

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Social Epidemiology of Hypertension in Buffalo City Metropolitan Municipality (BCMM): Cross sectional Study of Determinants of Prevalence, Awareness, Treatment and Control among South African Adults

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2016-014349.R1
Article Type:	Research
Date Submitted by the Author:	18-Jan-2017
Complete List of Authors:	OWOLABI, EYITAYO ; University of Fort Hare Department of Nursing Sciences, Department of Nursing Sciences Goon, Daniel ; University of Fort Hare Department of Nursing Sciences, Department of Nursing Sciences ADENIYI, OLADELE VINCENT; Cecilia Makiwane Hospital, DEPARTMENT OF FAMILY MEDICINE SEEKOE, EUNICE; University of Fort Hare Department of Nursing Sciences, Department of Nursing Sciences
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Cardiovascular medicine, General practice / Family practice, Global health, Public health, Patient-centred medicine
Keywords:	Hypertension < CARDIOLOGY, General diabetes < DIABETES & ENDOCRINOLOGY, Clinical governance < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PRIMARY CARE, PUBLIC HEALTH

Social Epidemiology of Hypertension in Buffalo City Metropolitan Municipality (BCMM): Cross sectional Study of Determinants of Prevalence, Awareness, Treatment and Control among South African Adults

***Eyitayo Omolara Owolabi[1], Daniel Ter Goon[2], *Oladele Vincent Adeniyi[3], Eunice Seekoe[4]**

1. *Department of Nursing Science, Faculty of Health Sciences, University of Fort Hare, East London, South Africa. Email: owolabiomolara101@gmail.com*
2. *Department of Nursing Science, Faculty of Health Sciences, University of Fort Hare, East London, South Africa. Email: dgoon@ufh.ac.za; daniel.goon2013@yahoo.com.*
3. *Department of Family Medicine, Faculty of Health Sciences, Walter Sisulu University/ Cecilia Makiwane Hospital, East London Hospital Complex, East London, South Africa. Email: vincoladele@gmail.com.*
4. *Department of Nursing Science, Faculty of Health Sciences, University of Fort Hare, East London, South Africa. Email: eseekoe@ufh.ac.za.*

***Corresponding Authors:**

Eyitayo Omolara Owolabi (BSc, MCur)

Department of Nursing Science, Faculty of Health Sciences,

University of Fort Hare, East London, 5200

South Africa. Email: 201502792@ufh.ac.za; owolabiomolara101@gmail.com

Tel: +27730719622

***Dr Oladele Vincent Adeniyi (FCFP, MMED, MPHIL, PhD Candidate)**

Department of Family Medicine & Rural Health,

Walter Sisulu University, Cecilia Makiwane Hospital,

East London Hospital Complex, East London, South Africa.

Email: vincoladele@gmail.com; vincent.adeniyi@echealth.gov.za

Tel: +27437082351; +27793110232.

Keywords: Blood Pressure Control, Diabetes mellitus, Hypertension, Obesity, South Africa

Word count: 4,037

5 tables and 1 figure

Abstract

Objectives: This study examined hypertension prevalence, awareness, treatment and control and their determinants among adults attending health facilities in BCMM in the Eastern Cape.

Design: A cross-sectional analytical study.

Settings: The three largest out-patient clinics in BCMM.

Participants: Ambulatory adults (18 years and over) attending the study settings during the study period (n=998).

Primary outcome measure: The prevalence of hypertension (systolic BP of ≥140mmHg and/or a diastolic BP of ≥ 90mmHg or current medication for hypertension), the awareness of it (prior diagnosis of it), and its treatment and control (Eighth Joint National Committee Criteria of blood pressure < 140/90 mmHg).

Secondary outcome measure: Associated factors of hypertension, hypertension unawareness and uncontrolled hypertension.

Results: Of the 998 participants included, the prevalence of hypertension was 49.2%. Hypertension unawareness was reported by 152 participants (23.1%) with significant gender difference (p=0.005). Male sex, age less than 45 years, higher level of education, single status, current employment, higher monthly income, current smoking, alcohol usage, absence of diabetes and non-obese were significantly associated (p<0.05) with hypertension unawareness.

Of the participants who were aware of having hypertension (n=339), nearly all (91.7%, n=311) were on anti-hypertensive medication and only 121 participants (38.9%) achieved the blood pressure treatment target. In the multivariate logistic regression model analysis, ageing (95%CI 1.9 to 4.4), being married (95%CI 1.0 to 2.0), male sex (95%CI 1.2 to 2.3), concomitant diabetes (95%CI 1.9 to 3.9), lower monthly income (95%CI 1.2 to 2.2), being unemployed (95%CI 1.0 to 1.9) and central obesity (95%CI 1.5 to 2.8) were the significant and independent determinants of prevalent hypertension.

Conclusion: The prevalence and awareness of hypertension was high in the study population. In addition, the sub-optimal control of blood pressure among treated individuals, as well as the significant cardiovascular risk factors, warrant the attention of health authorities of BCMM.

Strengths and limitations of the study

- **Large sample size of participants.**
- **First epidemiological data on hypertension prevalence, awareness, treatment and control in BCMM.**

- **Survey was conducted in BCMM's three largest out-patient clinics.**
- **Findings should be treated with caution in view of the cross-sectional design and convenience sampling.**

Introduction

Cardiovascular diseases (CVD) are the leading cause of death (17.3 million deaths) worldwide with a steep increase, especially in developing countries, and an 80% death toll prevalence.[1] Cardiovascular diseases have been predicted to account for about 23.6 million deaths by 2030.[2] Hypertension, one of the ten leading contributors to the global burden of disease, is the most important modifiable risk factor for cardiovascular diseases and an independent risk factor for mortality worldwide [3-6] and has been described as a silent killer due to its asymptomatic nature among the sufferers.[7] About nine million people die from hypertension annually.[8]

The prevalence of hypertension in Africa has been reported in several studies.[9-12] Hypertension was once considered a disease of affluence, but is now prevalent among the poor.[13] In 2012, one in three adults were reported to be hypertensive, with the highest prevalence recorded in Africa (50%).[14] South Africa is facing a serious burden of hypertension.[15] More than 6.2 million South Africans are hypertensive; 3.2 million have a blood pressure higher than 160/90mmHg and about 53 men and 78 women die daily from the effects of hypertension.[16] Considering the pace of economic growth in South Africa, a further increase in the prevalence of hypertension is expected if drastic actions are not implemented in the country.[17,18] The treatment and control of hypertension are associated with a reduced incidence of complications, such as stroke, coronary heart disease and kidney disease. [19-21]

While the majority of individuals with hypertension remain undiagnosed, there is evidence indicating sub-optimal control of blood pressure among individuals already in care for hypertension in South Africa.[22-25] Many reasons have been advanced for the sub-optimal treatment outcomes, such as socio-economic and behavioural factors and health system factors.[22,26-28]

In sub-Saharan Africa, the burden of hypertension is worsened by unreliable epidemiologic data, under-diagnosis, poor treatment and uncontrolled hypertension.[29-31] Epidemiologic data

helps to inform public health policies for the prevention and control of hypertension.[32] Likewise, prevention strategies, increased awareness, prompt detection, adequate treatment and control of blood pressure are basic requirements for a comprehensive approach for the reduction of hypertension, its complications and ultimately, its associated morbidity and mortality.[33]

There is a paucity of data on the prevalence, awareness and control of hypertension in the Eastern Cape, an understudied province in South Africa. Such a vital epidemiological data is needed to inform policies on non-communicable diseases and resource distribution and for the crafting of effective interventions. This study attempts to bridge the gap by determining the prevalence and associated factors of hypertension, awareness and controlled hypertension among adults attending the three largest out-patient clinics in the Buffalo City Municipality, Eastern Cape, South Africa.

Methods

Study area and design

This study analyzed data from the Buffalo City Metropolitan Municipality (BCMM) Non-Communicable Disease Surveillance study. We selected the three largest out-patient clinics serving the residents of Buffalo City Municipality, South Africa. These clinics provide primary health care services for the 755,200 residents of Buffalo City Municipality of Eastern Cape Province.[34] All medical conditions except acute emergency cases present first at the primary health care facilities prior to upward referrals to secondary health care facilities. The family medicine outpatient clinic of Cecilia Makiwane Hospital and Nontyatyambo Community Health Centre provide primary health care services to the predominantly black South African residents of Mdantsane Township, a semi-urban community of Eastern Cape. Empilweni-Gompo Community Health Centre was the third facility, situated in Duncan Village, a suburban community of East London.

Participants and Sample size

The sample size of the Buffalo City Metropolitan Municipality (BCMM) Non-Communicable Disease Surveillance study was based on the estimated proportion of individuals with hypertension in the population. We estimated a sample size of 1107 participants across the

three study sites (369 per site) based on the hypertension prevalence rate of 40% in South Africa[23], allowing for a sampling error of 5% with a 95% confidence level.

All ambulatory individuals (patients and their family members) who fulfilled the inclusion criteria and were attending the study settings during the period of study were recruited into the study. All participants with abnormal findings agreed to be evaluated by the clinicians at the study settings. This study was conducted in April-May, 2016. A convenience sampling method was utilized.

Eligibility criteria

Participants were included if aged ≥ 18 years, attending the out-patient clinics of the selected hospital and community health centres, were willing to participate and had fasted in the eight hours prior to recruitment into the study. Exclusion criteria included the acutely ill, psychotic, debilitated, pregnant or handicapped in any form such that obtaining anthropometric measurement would be difficult. A consecutive sample of 1107 participants took part in the study.

Study instrument

The participants were interviewed using the previously validated WHO STEPwise questionnaire[35] which comprises three major items; demographic and behavioural data, and measurements. The instrument was adapted locally and a pilot study, which included 20 participants at one of the sites, was conducted to validate its suitability to the local setting as well as to test the effectiveness of the research process. However, the results of the pilot study were not included in the main study.

Ethical considerations

Ethical approval was obtained in accordance with the Helsinki II Declaration from the University of Fort Hare Research Ethics Committee and the Eastern Cape Department of Health, reference number; GOO061SOLO01. The management of the sub-district department of health as well as the head of the respective health facilities gave permission prior to data collection. All participants provided written informed consent to participate in the study. Anonymity and confidentiality were ensured.

Data collection procedure

Data were obtained by personal interviews on demographic and behavioural characteristics and measurements of blood pressure, blood glucose and anthropometric parameters. Demographic variables included sex, age, marital status, level of education, employment status and average monthly income. Socioeconomic factors were measured by assessing the average monthly income, level of education and employment status. Participants were categorised as low income earners if they earned R2000 or less per month and middle income earners if they earned R2000 to R5000 and high-income earners if they earned above R5000. Level of education was obtained by self-reporting of the highest grade level attained in school; levels were categorised as no formal education, primary (grade 1-7), secondary (grade 8-12) or tertiary (post-secondary). Participants were defined as unemployed if they reported that they were not employed in either the formal or informal sectors.

The following behavioural variables were obtained by self-reporting; cigarette smoking, alcohol use, physical activity, and fruit and vegetables consumption patterns. Participants were questioned on their servings of fruit and vegetables daily. The smoking categories were; primary smokers (smoking directly), secondary smokers (if living with a smoker) or non-smoker. Physical activity levels of participants were obtained by self-reporting and categorized based on their engagement in moderate (yes/no) or vigorous intensity (yes/no) exercise leading to an increase in heart rate and respiratory rate, such as gardening.

Measurements

Blood pressure (systolic and diastolic) was measured in accordance with standard protocols[36] with a validated Microlife BP A100 Plus model. Hypertension was defined as an average of two systolic blood pressure of $\geq$ 140mmHg and diastolic of $\geq$ 90mmHg in accordance with the Eighth Joint National Committee (JNC 8) criteria. Participants who reported being informed of their hypertensive status by health professional(s) were considered aware. Uncontrolled hypertension among those on treatment with at least one or more anti-hypertensive medications was defined as systolic blood pressure greater than or equal to 140mmHg and diastolic blood pressure greater than or equal to 90mmHg, in accordance with JNC 8 criteria. The fasting blood glucose of each participant was measured with a validated ACCU-CHEK glucose monitoring apparatus in fasting state. Participants were diagnosed with diabetes if their fasting blood glucose level was equal or greater than 7.0 mmol/L or if they were on current medications for diabetes. They were defined as pre-diabetic if the fasting blood glucose fell between 6.1-6.9 mmol/L.[37]

Body weight was measured in light clothes to the nearest 0.01kg in the standing position using a Soehnle Scale (Soenle-Waagen Gmbh Co., Muurhardt, Germany) and height was measured to the nearest 0.1m by a stadiometer in standing position with closed feet (without shoes), holding their breath in full inspiration and Frankfurt line of vision.[38] Body mass index (BMI) was calculated as weight in kg divided by height in square metres (kg/m^2). BMI was categorized in accordance with WHO[39] as $<18.5kg/m^2$, $18.5\text{-}24.9kg/m^2$, $25.5\text{-}29.9kg/m^2$ and $>30.0kg/m^2$ as underweight, normal, overweight and obese, respectively.

Statistical analysis

Data were expressed as mean values ± standard deviations (SD) for continuous variables. Counts (frequencies=n) and proportions (%) were reported for categorical variables. A bivariate analysis was used to examine variables that have a significant association with hypertension and a p-value < 0.05 was considered statistically significant. The significant variables were included in the binary logistic regression and were adjusted for confounding factors. Analysis was carried out at a 95% confidence level. Statistical analysis was performed with the Statistical Package for Social Science (SPSS) version 21 for windows (SPSS Inc., Chicago, IL, USA).

Results

Our analysis was based on 988 participants with complete data responses; 321 were males and 677 were females (response rate, 92%). Eight percent of the participants were excluded from the study because of incomplete documentation of blood pressure, blood glucose, weight or height. More than half of the respondents – 56.5% of males and 60.2% of females – were between the ages of 18 and 45 years. With respect to income level, 69.4% of men and 80.9% of women, either had no source of income or earned less than R2000 per month. Table 1 provides the descriptive characteristics of the participants.

Table 1 Demographic characteristics of the participants by sex

Variables	Male (n=321) n(%)	Female (n=677) n(%)	Total (n=998) n(%)	p-value
Age group (years)				
18-25	40(12.5)	143(21.1)	183(18.3)	
26-35	74(23.1)	149(22.0)	223(22.3)	
36-45	67(20.9)	116(17.1)	183(18.3)	0.009
46-55	57(17.8)	110(16.2)	167(16.7)	
56-65	41(12.8)	99(14.6)	140(14.0)	
≥66	42(14.1)	60(8.9)	102(10.2)	
Level of education				
No formal schooling	62(19.3)	84(12.4)	146(14.6)	
Grade 1-7	57(17.8)	99(14.6)	156(15.6)	0.008
Grade 8-12	171(53.3)	409(60.4)	580(58.1)	
Tertiary	31(9.7)	85(12.6)	116(11.6)	
Monthly income (Rands)				
No income	134(41.7)	300(44.3)	445(44.6)	
R150-2000	89(27.7)	248(36.6)	326(32.7)	0.000
R2001-5000	74(23.1)	100(14.8)	174(17.4)	
R5001and above	24(7.5)	29(4.3	53(5.3)	
Marital status				
Single	193(60.3)	444(65.6)	637(63.9)	
Married	115(35.9)	185(27.3)	300(30.1)	
Separated	1(0.3)	5(0.7)	6(0.6)	0.002
Divorced	9(2.8)	13(1.9)	22(2.2)	
Widowed	2(0.6)	30(4.4)	32(3.2)	
Racial group				
Black	313(97.5)	666(98.4)	979(98.1)	
Coloured	8(2.8)	9(1.3)	17(1.7)	0.026
White	0(0.0)	2(0.3)	2(0.2)	
Type of employment				
Government employee	30(9.3)	33(4.9)	63(6.3)	
Non-government employment	98(30.5)	133(19.7)	231(23.2)	
Self-employment	30(9.3)	32(4.7)	62(6.2)	
Students	19(5.9)	80(11.8)	99(9.9)	0.000
Unemployed	115(35.8)	361(53.4)	476(47.7)	
Retired	29(9.0)	37(5.5)	66(6.6)	

Prevalence, awareness and treatment of hypertension

Of the 998 participants, 49.2% (n=491) were diagnosed with hypertension (Figure 1). Awareness of prior diagnosis of hypertension was reported by 339 participants (69.1% of total hypertensive individuals). Among those aware of having hypertension, nearly all (91.7%, n=311) were on anti-hypertensive medication. Treatment to target blood pressure occurred in 38.9% (n=121) of treated individuals.

Factors associated with hypertension

In bivariate analysis (Table 2), the following risk factors; ageing, male sex, lower level of education (below grade 8), being married, unemployed, lower income level, never drank

alcohol, sedentary lifestyle and both central and overall obesity were significantly associated with hypertension. Body mass index and age demonstrated positive linear associations with prevalent hypertension.

Table 2 Bivariate analysis showing the associated risk factors for hypertension

Variables	Hypertensive	Normal BP	RR	95% CI	p-value
Sex					
Male	175(54.5)	146(45.5)	1.4	1.0-1.8	0.012
Female	316(46.7)	361(53.3)			
Age (years)					
≤25	35(19.1)	148(80.9)	-	-	0.000
26-35	66(29.6)	157(70.4)			
36-45	72(39.3)	111(60.7)			
46-55	133(67.7)	54(32.3)			
56-65	117(83.6)	23(16.4)			
≥66	88(86.3)	14(13.7)			
Level of education					
No formal schooling	77(52.7)	69(47.3)			0.000
Grade 1 to 7	118(75.6)	38(24.4)			
Grade 8 to 12	250(43.1)	330(56.9)			
Tertiary	46(39.7)	70(60.3)			
Marital status					
Never married	251(39.4)	386(60.6)	0.4	0.3-0.5	0.000
Married	211(64.3)	117(35.7)			
Employment					
Government employee	33(52.4)	30(47.6)	-	-	0.000
Non-government employee	104(45.0)	127(55.0)			
Self-employed	29(46.8)	33(53.2)			
Student	18(18.2)	81(81.8)			
Unemployed	252(52.9)	224(47.1)			
Retired	54(81.8)	12(18.2)			
Monthly income					
R2000	222(62.2)	135(37.8)	1.9	1.4-2.7	0.000
≥R2001	105(46.3)	122(53.7)			
Ever drink alcohol					
Yes	131(41.1)	188(58.9)	0.6	0.5-0.8	0.000
No	359(53.7)	310(46.3)			
Moderate intensity physical activity					
Yes	256(45.6)	305(54.4)	0.7	0.6-0.9	0.006
No	234(53.8)	201(46.2)			
Vigorous intensity physical activity					
Yes	58(37.9)	95(62.1)	0.6	0.4-0.8	0.002
No	433(51.5)	412(48.8)			
Body mass index (kg/m^2)					
Underweight	12(37.5)	20(62.5)	-	-	0.000
Normal	89(33.0)	181(67.0)			
Overweight	106(45.3)	128(54.7)			
Stage 1 obesity	114(55.6)	91(44.4)			
Stage 2 obesity	84(60.9)	54(39.1)			
Stage 3 obesity	76(72.4)	29(27.6)			
Central obesity derived from waist-to-hip ratio					
Yes	268(56.8)	204(43.2)	0.6	0.4-0.7	0.000
No	221(42.3)	301(57.7)			
WC derived central obesity					
Obese	355(54.7)	294(45.3)	0.5	0.4-0.7	0.000
Not obese	135(38.9)	212(61.1)			

RR= Relative risk; CI= Confidence interval

In the multivariate logistic regression model analysis (Table 3), ageing, being married, male sex, concomitant diabetes mellitus, lower income level, being unemployed and central obesity were the significant and independent determinants of prevalent hypertension.

Table 3 Multivariate logistic regression analysis showing the predictors of hypertension

Variables	Beta	Wald	AOR (95% CI)	p-value
Age				
≤26 (Reference)				
Above 26	1.06	23.78	2.9(1.9-4.4)	0.005
Marital status				
Never married (Reference)				
Ever married	0.39	5.89	1.5(1.0-2.0)	0.015
Sex				
Female (Reference)				
Male	0.51	9.83	1.7(1.2-2.3)	0.000
Diabetes mellitus				
No (Reference)				
Yes	1.01	31.6	2.7(1.9-3.9)	0.000
Monthly income				
Middle-income >2000 (Reference)				
Low income ≤ 2000	0.49	9.48	1.6(1.2-2.2)	0.002
Employment				
Employed (Reference)				
Unemployed	0.33	4.01	1.4(1.0-1.9)	0.045
Central obesity derived from waist circumference				
No (Reference)				
Yes	0.63	10.0	2.1(1.5-2.8)	0.000

AOR=Adjusted odd ratios; CI= Confidence interval

Factors associated with hypertension awareness and control

Hypertension unawareness occurred in 152 participants with significant difference by sex (p=0.005). The following factors; male sex, lower age, higher level of education, single status, current employment status, higher income earners, current smokers, alcohol users, non-diabetic and non-obese individuals were associated with hypertension unawareness in the study (Table 4).

Table 4 Bivariate analysis showing the associated factors of hypertension awareness

Variables	Aware	Unaware	RR	95% CI	p-value
Sex					
Male	108(61.7)	67(38.3)	0.6	0.4-0.9	0.005
Female	232(73.4)	84(26.6)			
Age (years)					
<45	79(23.2.)	95(54.6)	0.5	0.1-0.3	0.000
>45	261(82.3)	56(17.7)			
Level of education					
No formal schooling	57(73.1)	21(26.9)	-	-	0.002
Grade 1-7	93(78.8)	25(21.1)			
Grade 8-12	168(67.2)	82(32.8)			
Tertiary	22(48.9)	23(51.1)			
Marital status					
Never married	152(60.6)	99(39.4)	0.5	0.3-0.7	0.000
Married	161(76.3)	50(23.7)			
Employment status					
Employed	99(59.3)	68(40.7)	0.5	0.3-0.7	0.000
Unemployed	241(74.4)	83(25.6)			
Monthly income (Rands)					
<R2000	276(71.7)	109(28.3)	1.7	1.1-2.6	0.018
>R2000	64(60.4)	42(39.6)			
Current smokers					
Yes	33(50.0)	33(50.0)	0.4	0.2-0.7	0.000
No	307(72.2)	118(27.8)			
Ever drink alcohol					
Yes	67(50.8)	65(49.2)	0.3	0.2-0.5	0.000
No	272(76.2)	85(23.8)			
Diabetes mellitus					
Yes	114(85.1)	20(14.9)			
No	226(63.3)	131(36.7)	0.3	0.2-0.5	0.000
Obesity					
Yes	260(73.4)	94(26.6)	2.5	1.5-3.2	0.001
No	79(58.1)	57(41.9)			

RR= Relative risk; CI= Confidence interval

Among the participants on treatment for hypertension (n=311), only level of education (no formal schooling) was associated with uncontrolled hypertension. Concomitant diabetes mellitus was not significantly associated with uncontrolled hypertension (Table 5).

Table 5 Bivariate analysis showing the factors associated with hypertension control

Variables	Controlled HTN	Uncontrolled HTN	RR	95% CI	p-value
Sex					
Male	34(35.4)	62(64.4)	0.8	0.5-1.3	0.262
Female	86(40.0)	129(60.0)			
Age (years)					
<45	31(47.7)	34(52.3)	1.6	0.9-2.8	0.061
>45	89(36.2)	157(63.8)			
Level of education					
No formal schooling	11(23.9)	35(76.1)	-	-	0.048
Grade 1-7	32(36.0)	57(64.0)			
Grade 8-12	68(43.0)	90(57.0)			
Tertiary	10(55.6)	8(44.4)			
Marital status					
Never married	56(42.4)	76(57.6)	0.8	0.5-1.2	0.165
Married	65(36.3)	114(63.7)			
Employment status					
Employed	36(41.4)	51(58.6)	0.9	0.5-1.4	0.344
Unemployed	85(38.1)	138(61.9)			
Monthly income (Rands)					
<R2000	98(38.9)	154(61.1)	1.0	0.6-1.8	0.551
>R2000	23(39.0)	36(61.0)			
Current smokers					
Yes	11(39.3)	17(60.7)	1.0	0.5-2.3	0.544
No	109(38.5)	174(61.5)			
Ever drink alcohol					
Yes	18(32.7)	37(67.3)	0.7	0.4-1.3	0.204
No	102(39.8)	154(60.2)			
Diabetes mellitus					
Yes	87(56.9)	66(43.1)	0.7	0.4-1.1	0.052
No	105(66.5)	53(33.5)			
Obesity					
Yes	76(36.8)	125(62.2)	0.9	0.6-1.5	0.398
No	44(40.0)	66(60.0)			

RR= Relative risk; CI= Confidence interval; HTN= Hypertension

Discussion

To the best knowledge of the authors, this is the first paper addressing epidemiological gaps regarding the prevalence, awareness, treatment and control of hypertension in the Buffalo City Metropolitan Municipality (BCMM). We found a high prevalence of hypertension (49.2%) in our study population. There seems to be an upward trend in the prevalence of hypertension in the country which is rather unsurprising, given rapid urbanization and its consequent effects on population health. Our result is higher than that in Day et al.'s [23] study, which reported a 40% prevalence of hypertension among South African adults in 2010. A lower prevalence of hypertension (38.9%) was reported by Peer et al.[25] among black urban South African adults between the ages of 24 and 65 years in Cape Town. A nationally representative house-hold survey in South Africa which included individuals aged 15 years and above reported a prevalence range of 9% in Limpopo Province to 22.3% in Northern

Cape Province.[34] The highest prevalence of hypertension (12.4%) was found among the black South African population. Weimann et al.[40] estimated a higher prevalence, at 37% and 52%, in the Eastern Cape and Northwest Provinces. The higher prevalence of 49.2% found among our sample is comparable to Northwest Province's 52%, but higher than the percentage reported for the Eastern Cape Province by Weimann et al.[40] with an almost similar age distribution. Our result was obtained from the primary health care setting and thus, may have slightly overestimated the prevalence in the population. However, considering the age distribution of the study participants, with more than half below the of age 45, such a high prevalence of hypertension further signifies the need for urgent interventions as population ageing is often associated with a higher prevalence of hypertension

There is a wide variation in the prevalence of hypertension across sub-Saharan Africa; from 23% among Zambian and Angolan adults to 26% in adults in four selected sub-Saharan African countries.[10-12,41] Akpan et al. [9] reported a prevalence of 48.3% among rural adults in the eastern part of Nigeria, while a 44.7% prevalence was documented among rural Ghanaian adults. Similar trends of increasing hypertension prevalence have been reported worldwide; Chow et al.[30] found a prevalence of 40.8% among rural and urban dwellers in selected high-income countries (Canada, Sweden, United Arab Emirates), middle-income countries (Argentina, Brazil, Chile, Poland, Turkey, Malaysia, South Africa, China, Colombia and Iran) and low-income countries (Bangladesh, India, Pakistan and Zimbabwe). A higher prevalence was reported in certain other developing countries, with prevalence ranging from 50.7% to 79.8% among adults living in urban areas of India, Latin America and China.[42,43] Our finding further supports the epidemiological shift of non-communicable diseases to developing nations.[13,44]

Although a thorough comparison of various studies cannot be done as a result of differences in the definitions, methodology and populations used, the findings from this study indicate that South Africa is already at the forefront of the epidemiologic transition. The shift is being exacerbated by advancements in technology attributed to urbanization and westernization. These are both the driving forces of the increasing burden of non-communicable disease risk factors of which hypertension is predominant. It is linked to the adoption of unhealthy lifestyle behaviours, poor dietary practices and poor engagement in physical activity, leading to obesity, and ultimately, cardiovascular risk factors like hypertension. Our findings signal a

looming burden of non-communicable disease among the study participants if urgent actions are not taken.

We found ageing, male sex, being married, unemployment status, poverty, sedentary lifestyles, obesity and diabetes mellitus as the important determinants of prevalent hypertension in the study population. Several other studies have also established a link between these risk factors. Pires et al.[12] affirmed that increasing age, lower level of education and increasing weight were associated with hypertension. Additionally, Guwatudde et al.[11] found diabetes to be significantly associated with hypertension. Increasing age is often associated with changes in the body systems, including the cardiovascular system such as the heart and arteries. Old people suffer a great deal of cardiovascular risk factors, especially hypertension.[45]

We found a higher prevalence of hypertension in individuals with a lower level of education (below grade 8). These individuals are most likely to be unemployed and to earn less than R2000 per month. The association between level of education and health is rather complex; it can be assumed that the more educated an individual is, the more knowledgeable he will be on matters of health. Whether this assumption is true in our study population is rather speculative. Cutler and Lleras-Muney[46] reported that education increases knowledge. Educated individuals are more likely to be receptive to new developments, including newly approved drugs, and are often compliant with drug use.[47,48] Our study participants with hypertension were poor and unemployed. Their socio-economic status limited their access to healthy foods and increased their consumption of readily available, cheap foods which contribute to risk factors such as obesity and hypertension. This should, however, be interpreted with caution, as being unemployed does not necessarily denote a low income. Underlying factors associated with unemployment, such as psychological stress, could contribute to the high prevalence of hypertension among this cohort. We found a higher prevalence of hypertension among men. Female hormonal effect is believed to be protective[49] and since the majority of the women in this study were below the age of 50, this could be a plausible reason for our findings. Also, obesity, work stress, physical inactivity, alcohol intake and salt intake have been reported to be high in men, resulting in higher odds of men developing hypertension.[50]

There is a substantial intersection between hypertension and diabetes because of the shared metabolic pathway and risk factors.[51-53] Hypertension is always found in more than half of individuals with type-2 diabetes and the chances of developing hypertension among persons with type-2 diabetes is more than double than that amongst non-diabetic persons.[54] Also, as shown by Murphy et al. and Bromfield & Munter,[55,56] there is a recognized link between hypertension, obesity, smoking, harmful use of alcohol and physical inactivity and a large percentage of the hypertension burden is attributed to these factors. The relationship between hypertension and obesity has long been established. Obesity increases the chance of developing hypertension and increases the risk of developing cardiovascular complications.[57,58] As reported by Pandey et al, [59] smoking increases the prevalence of hypertension.[53] Physical inactivity is a precursor to obesity and hypertension. Physical inactivity is responsible for 20% of hypertension cases.[60]

The present study further illustrates that the majority (69.1%) of the hypertensive patients were aware of their status, and of these, almost all (91.7%) were already on treatment with only 38.9% achieving control. This awareness rate is higher than the 24% awareness rate reported among South Asian adults.[61] There is a wide variation of hypertension awareness across African countries with rates ranging from 8% in Nigeria to 81% among elderly individuals in Tunisia.[62] Also, the study settings being health facilities might have contributed to the high awareness prevalence recorded in this study.

Despite scientific successes in anti-hypertensive drug discoveries, achieving treatment targets remains a serious challenge. Although nearly all of the participants with prior diagnosis were already receiving treatment for hypertension, a commendable effort, only 38.9% achieved treatment targets. This is somewhat better than previous studies conducted in Mthatha, South Africa (25.5%) and Zimbabwe, (32.8%).[22,31] It is also comparable to the rate of control of hypertension (36.4%) reported by Day et al.[23] in a household survey conducted among South African adults in 2010. Generally, hypertension control has been reported to be sub-optimal in Africa, ranging from 2.6% in Kenya to 42.2% in Ethiopia.[62-64]

We observed that men, those earning more than R2000 per month, those aged under 45 years, employed, cigarette smokers and alcohol users had higher rates of hypertension unawareness. Men have been reported to have higher odds of developing hypertension and the high rate of unawareness among them is not surprising. Females have been recognized as more likely to

seek healthcare than men.[65] Traditional gender roles in Africa account for the under-utilization of health facilities among men; men are the breadwinners and are perceived as healthy.[66,67] Hence, they rarely seek health facilities for screening purposes unless they are sick. Hypertension is largely asymptomatic and this being the case, an affected individual will rarely seek healthcare. Our findings have serious public health consequences, due to the clustering of cardiovascular diseases among the individuals with hypertension unawareness. Younger individuals are unlikely to visit health facilities without any major sickness. Hence the high rate of unawareness in those younger than 45 years. Besides, this cohort of individuals are pre-occupied by their jobs. Older individuals tend to have multi-morbidity and as such, would have had several opportunities to be screened for non-communicable diseases. Alcohol-and nicotine-dependence may explain our findings of high unawareness among alcohol users and current cigarette smokers, respectively.

We found a high rate of uncontrolled hypertension (62.4%) in our study participants. Several factors have been implicated for the poor control of hypertension in Africa, which are generally related to deficiencies in the healthcare system, non-adherence to medication regimens by patients and physicians' inertia to optimize treatment of hypertension.[22,62] Several studies have documented the unavailability of anti-hypertensive drugs as well as non-adherence to clinic visits by patients as a result of lack of transportation and time.[12,68,69] Poor treatment outcomes in Africa has been documented extensively.[13,31,62,70,71] In comparison, higher levels of control (64.8% and 66%) of hypertension were reported in the USA and Canada, respectively.[72,73] This is not a surprise as the management of hypertension is costly due to its chronic nature. Developed countries have been recording successes in the reduction of the burden related to hypertension and other non-communicable diseases.[74]

Also, participants who had diabetes mellitus were found to have a lower rate of controlled hypertension. Multi-morbidity with significant risks of poly-pharmacy are some of the reasons for the poor control of blood pressure in those with concomitant diabetes. A study in a similar setting by Adeniyi et al.[22] found poor control of blood pressure among individuals with concomitant diabetes. Illiteracy was associated with poor blood pressure control among our study participants already on treatment for hypertension. Poor treatment outcomes among individuals with no formal education is not surprising. Despite the availability of medications at the health facility, some of our patients regularly miss appointments and fail to collect medications. Education is said to be "power" and Cutler and Lleras-Muney[46] assert that education increases knowledge. There is a possibility of a lack of adequate knowledge on the

importance of medication use in the control of hypertension among illiterate persons. In addition, the benefits of positive lifestyle behaviours for the control of hypertension might not be fully appreciated by such individuals. Likewise, lack of education generally leads to poverty; thus poorly educated patients are less likely to be able to purchase essential drugs for hypertension or to eat as healthily, as healthy foods tend to cost far more low-cost, carbohydrate-rich foods.[75]

Strengths and limitations

The limitations of the study cannot be ignored. Firstly, this was a cross-sectional study, hence causality cannot be ascribed to the determinants. Our findings should be interpreted with caution in view of the convenience sampling of the participants at primary health care facilities. We also did not obtain information on the hypertensive medications being used and therefore could not gain a full understanding of the uncontrolled hypertension in our study participants. Notwithstanding these limitations, the findings of the study provide useful epidemiological data in view of the large sample size, the large out-patient clinics selected and the previously understudied setting.

CONCLUSION

The findings of a high prevalence of hypertension and sub-optimal blood pressure control of hypertension requires the urgent attention of health authorities in Buffalo City Metropolitan Municipality. Also, the clustering of cardiovascular risk factors in individuals with hypertension suggests that an integrated strategy addressing all the non-communicable diseases will be needed to mitigate the looming epidemic. Strategies aimed at the prevention of hypertension, its early diagnosis and treatment to target blood pressure levels are needed in BCMM. Also, the re-engineering of the primary health care system will be crucial towards dealing with the burden of non-communicable diseases in the region.

Consent for publication

All authors approved the submission of this final draft towards publication in a peer reviewed journal.

Availability of data and materials

Data from this study will be made available on request.

Competing interests

The authors declare no conflict of interest.

Funding

EOO received master's study grants from the National Research Foundation and the Health and Welfare Sector Education and Training Authority, South Africa towards the implementation of the project.

Authors' contributions

EOO, DTG and OVA conceptualised, designed and drafted the paper. ES participated in data collection and gave intellectual contribution into the manuscript. All authors read and approved the final manuscript.

Acknowledgements

The authors are grateful to the management and the nursing staff of the three health facilities for their support towards the successful implementation of the project.

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Figure 1. Prevalence of Hypertension

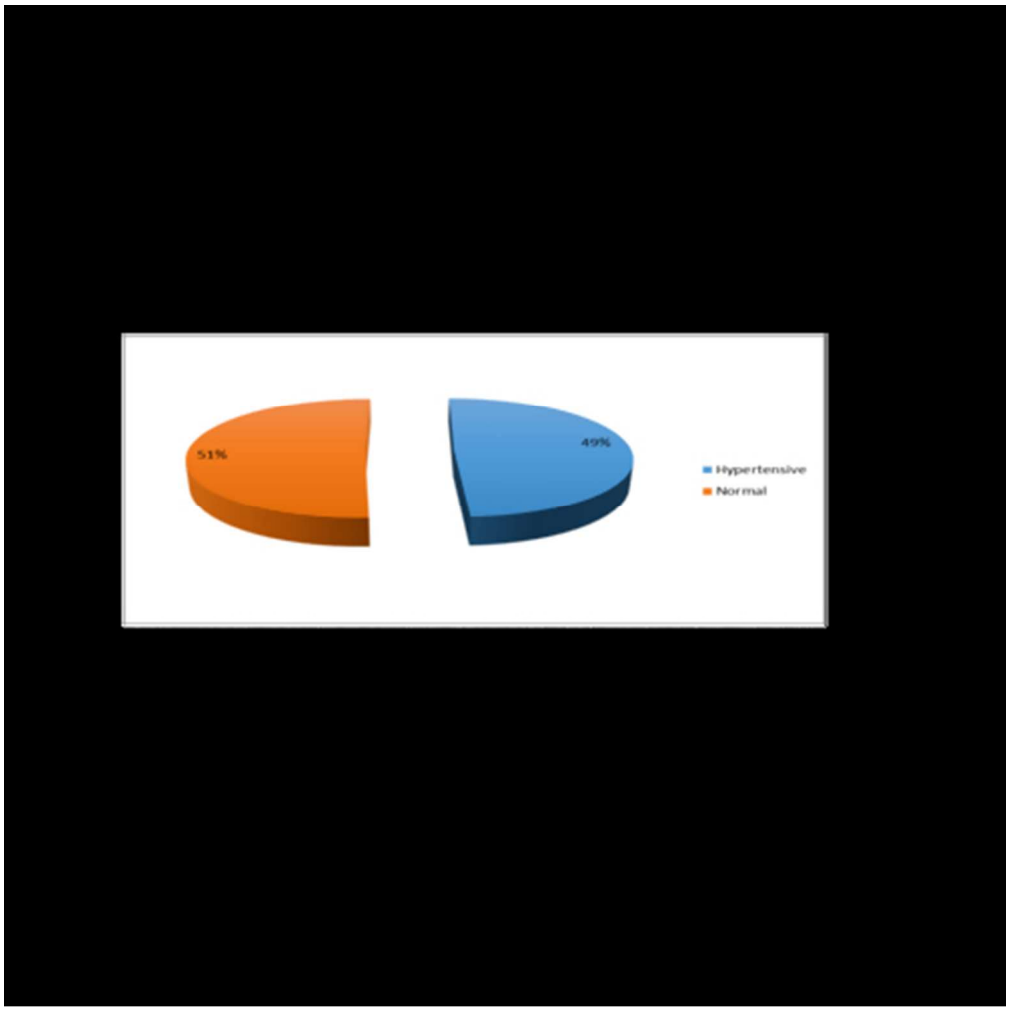

Figure 1. Prevalence of Hypertension

42x42mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract. – Page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found – Page 2
Introduction		
Background/rationale-pg	2	Explain the scientific background and rationale for the investigation being reported – page 3 to 4
Objectives	3	State specific objectives, including any pre-specified hypotheses – Page 4
Methods		
Study design	4	Present key elements of study design early in the paper – Page 4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection – Page 4 to 7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants – Page 4 to 5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable – Page 6 to 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 – Page 6 to 7
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at – Page 4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why – Page 7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding – Page 7
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy – Page 7
		(*e*) Describe any sensitivity analyses

Continued on next page

Results – Pg 7		
Participants	13*	(a) 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
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders – Page 7 to 8
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) 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 – Page 8 to 12.
		(*b*) Report category boundaries when continuous variables were categorized. Page 8 to 12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives – Page 12 to 17
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 – Page 17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence – Page 17
Generalisability	21	Discuss the generalisability (external validity) of the study results – Page 17
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 – Page 18

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Social Epidemiology of Hypertension in Buffalo City Metropolitan Municipality (BCMM): Cross sectional Study of Determinants of Prevalence, Awareness, Treatment and Control among South African Adults

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2016-014349.R2
Article Type:	Research
Date Submitted by the Author:	28-Mar-2017
Complete List of Authors:	OWOLABI, EYITAYO ; University of Fort Hare Department of Nursing Sciences, Department of Nursing Sciences Goon, Daniel ; University of Fort Hare Department of Nursing Sciences, Department of Nursing Sciences ADENIYI, OLADELE VINCENT; Cecilia Makiwane Hospital, DEPARTMENT OF FAMILY MEDICINE SEEKOE, EUNICE; University of Fort Hare Department of Nursing Sciences, Department of Nursing Sciences
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Cardiovascular medicine, General practice / Family practice, Global health, Public health, Patient-centred medicine
Keywords:	Hypertension < CARDIOLOGY, General diabetes < DIABETES & ENDOCRINOLOGY, Clinical governance < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PRIMARY CARE, PUBLIC HEALTH

Social Epidemiology of Hypertension in Buffalo City Metropolitan Municipality (BCMM): Cross sectional Study of Determinants of Prevalence, Awareness, Treatment and Control among South African Adults

***Eyitayo Omolara Owolabi[1], Daniel Ter Goon[2], *Oladele Vincent Adeniyi[3], Eunice Seekoe[4]**

1. *Department of Nursing Science, Faculty of Health Sciences, University of Fort Hare, East London, South Africa. Email: owolabiomolara101@gmail.com*
2. *Department of Nursing Science, Faculty of Health Sciences, University of Fort Hare, East London, South Africa. Email: dgoon@ufh.ac.za; daniel.goon2013@yahoo.com.*
3. *Department of Family Medicine, Faculty of Health Sciences, Walter Sisulu University/ Cecilia Makiwane Hospital, East London Hospital Complex, East London, South Africa. Email: vincoladele@gmail.com.*
4. *Department of Nursing Science, Faculty of Health Sciences, University of Fort Hare, East London, South Africa. Email: eseekoe@ufh.ac.za.*

***Corresponding Authors:**

Eyitayo Omolara Owolabi (BSc, MCur)

Department of Nursing Science, Faculty of Health Sciences,

University of Fort Hare, East London, 5200

South Africa. Email: 201502792@ufh.ac.za; owolabiomolara101@gmail.com

Tel: +27730719622

***Dr Oladele Vincent Adeniyi (FCFP, MMED, MPHIL, PhD Candidate)**

Department of Family Medicine & Rural Health,

Walter Sisulu University, Cecilia Makiwane Hospital,

East London Hospital Complex, East London, South Africa.

Email: vincoladele@gmail.com; vincent.adeniyi@echealth.gov.za

Tel: +27437082351; +27793110232.

Keywords: Blood Pressure Control, Diabetes mellitus, Hypertension, Obesity, South Africa

Word count: 4,037

5 tables and 1 figure

Abstract

Objectives: This study examined hypertension prevalence, awareness, treatment and control and their determinants among adults attending health facilities in BCMM in the Eastern Cape.

Design: A cross-sectional analytical study.

Settings: The three largest out-patient clinics in BCMM.

Participants: Ambulatory adults (18 years and over) attending the study settings during the study period (n=998).

Primary outcome measure: The prevalence of hypertension (systolic BP of ≥140mmHg and/or a diastolic BP of ≥ 90mmHg or current medication for hypertension), the awareness of it (prior diagnosis of it), and its treatment and control (Eighth Joint National Committee Criteria of blood pressure < 140/90 mmHg).

Secondary outcome measure: Associated factors of hypertension, hypertension unawareness and uncontrolled hypertension.

Results: Of the 998 participants included, the prevalence of hypertension was 49.2%. Hypertension unawareness was reported by 152 participants (23.1%) with significant gender difference (p=0.005). Male sex, age less than 45 years, higher level of education, single status, current employment, higher monthly income, current smoking, alcohol usage, absence of diabetes and non-obese were significantly associated (p<0.05) with hypertension unawareness.

Of the participants who were aware of having hypertension (n=339), nearly all (91.7%, n=311) were on anti-hypertensive medication and only 121 participants (38.9%) achieved the blood pressure treatment target. In the multivariate logistic regression model analysis, ageing (95%CI 1.9 to 4.4), being married (95%CI 1.0 to 2.0), male sex (95%CI 1.2 to 2.3), concomitant diabetes (95%CI 1.9 to 3.9), lower monthly income (95%CI 1.2 to 2.2), being unemployed (95%CI 1.0 to 1.9) and central obesity (95%CI 1.5 to 2.8) were the significant and independent determinants of prevalent hypertension.

Conclusion: The prevalence and awareness of hypertension was high in the study population. In addition, the sub-optimal control of blood pressure among treated individuals, as well as the significant cardiovascular risk factors, warrant the attention of health authorities of BCMM and the country.

Strengths and limitations of the study

- **Large sample size of participants.**
- **First epidemiological data on hypertension prevalence, awareness, treatment and control in BCMM.**

- **Survey was conducted in BCMM's three largest out-patient clinics.**
- **Findings should be treated with caution in view of the cross-sectional design and convenience sampling.**

Introduction

Cardiovascular diseases (CVD) are the leading cause of death (17.3 million deaths) worldwide with a steep increase, especially in developing countries, and an 80% death toll prevalence.[1] Cardiovascular diseases have been predicted to account for about 23.6 million deaths by 2030.[2] Hypertension, one of the ten leading contributors to the global burden of disease, is the most important modifiable risk factor for cardiovascular diseases and an independent risk factor for mortality worldwide [3-6] and has been described as a silent killer due to its asymptomatic nature among the sufferers.[7] About nine million people die from hypertension annually.[8]

The prevalence of hypertension in Africa has been reported in several studies.[9-12] Hypertension was once considered a disease of affluence, but is now prevalent among the poor.[13] In 2012, one in three adults were reported to be hypertensive, with the highest prevalence recorded in Africa (50%).[14] South Africa is facing a serious burden of hypertension.[15] More than 6.2 million South Africans are hypertensive; 3.2 million have a blood pressure higher than 160/90mmHg and about 53 men and 78 women die daily from the effects of hypertension.[16] Considering the pace of economic growth in South Africa, a further increase in the prevalence of hypertension is expected if drastic actions are not implemented in the country.[17,18] The treatment and control of hypertension are associated with a reduced incidence of complications, such as stroke, coronary heart disease and kidney disease. [19-21]

While the majority of individuals with hypertension remain undiagnosed, there is evidence indicating sub-optimal control of blood pressure among individuals already in care for hypertension in South Africa.[22-25] Many reasons have been advanced for the sub-optimal treatment outcomes, such as socio-economic and behavioural factors and health system factors.[22,26-28]

In sub-Saharan Africa, the burden of hypertension is worsened by unreliable epidemiologic data, under-diagnosis, poor treatment and uncontrolled hypertension.[29-31] Epidemiologic data

helps to inform public health policies for the prevention and control of hypertension.[32] Likewise, prevention strategies, increased awareness, prompt detection, adequate treatment and control of blood pressure are basic requirements for a comprehensive approach for the reduction of hypertension, its complications and ultimately, its associated morbidity and mortality.[33]

There is a paucity of data on the prevalence, awareness and control of hypertension in the Eastern Cape, an understudied province in South Africa. Such a vital epidemiological data is needed to inform policies on non-communicable diseases and resource distribution and for the crafting of effective interventions. This study attempts to bridge the gap by determining the prevalence and associated factors of hypertension, awareness and controlled hypertension among adults attending the three largest out-patient clinics in the Buffalo City Municipality, Eastern Cape, South Africa.

Methods

Study area and design

This study analyzed data from the Buffalo City Metropolitan Municipality (BCMM) Non-Communicable Disease Surveillance study. We selected the three largest out-patient clinics serving the residents of Buffalo City Municipality, South Africa. These clinics provide primary health care services for the 755,200 residents of Buffalo City Municipality of Eastern Cape Province.[34] All medical conditions except acute emergency cases present first at the primary health care facilities prior to upward referrals to secondary health care facilities. The family medicine outpatient clinic of Cecilia Makiwane Hospital and Nontyatyambo Community Health Centre provide primary health care services to the predominantly black South African residents of Mdantsane Township, a semi-urban community of Eastern Cape. Empilweni-Gompo Community Health Centre was the third facility, situated in Duncan Village, a suburban community of East London.

Participants and Sample size

The sample size of the Buffalo City Metropolitan Municipality (BCMM) Non-Communicable Disease Surveillance study was based on the estimated proportion of individuals with hypertension in the population. We estimated a sample size of 1107 participants across the

three study sites (369 per site) based on the hypertension prevalence rate of 40% in South Africa[23], allowing for a sampling error of 5% with a 95% confidence level.

All ambulatory individuals (patients and their family members) who fulfilled the inclusion criteria and were attending the study settings during the period of study were recruited into the study. All participants with abnormal findings agreed to be evaluated by the clinicians at the study settings. This study was conducted in April-May, 2016. A convenience sampling method was utilized.

Eligibility criteria

Participants were included if aged ≥ 18 years, attending the out-patient clinics of the selected hospital and community health centres, were willing to participate and had fasted in the eight hours prior to recruitment into the study. Exclusion criteria included the acutely ill, psychotic, debilitated, pregnant or handicapped in any form such that obtaining anthropometric measurement would be difficult. A consecutive sample of 1107 participants took part in the study.

Study instrument

The participants were interviewed using the previously validated WHO STEPwise questionnaire[35] which comprises three major items; demographic and behavioural data, and measurements. The instrument was adapted locally and a pilot study, which included 20 participants at one of the sites, was conducted to validate its suitability to the local setting as well as to test the effectiveness of the research process. However, the results of the pilot study were not included in the main study.

Ethical considerations

Ethical approval was obtained in accordance with the Helsinki II Declaration from the University of Fort Hare Research Ethics Committee and the Eastern Cape Department of Health, reference number; GOO061SOLO01. The management of the sub-district department of health as well as the head of the respective health facilities gave permission prior to data collection. All participants provided written informed consent to participate in the study. Anonymity and confidentiality were ensured.

Data collection procedure

Data were obtained by personal interviews on demographic and behavioural characteristics and measurements of blood pressure, blood glucose and anthropometric parameters. Demographic variables included sex, age, marital status, level of education, employment status and average monthly income. Socioeconomic factors were measured by assessing the average monthly income, level of education and employment status. Participants were categorised as low income earners if they earned R2000 or less per month and middle income earners if they earned R2000 to R5000 and high-income earners if they earned above R5000. Level of education was obtained by self-reporting of the highest grade level attained in school; levels were categorised as no formal education, primary (grade 1-7), secondary (grade 8-12) or tertiary (post-secondary). Participants were defined as unemployed if they reported that they were not employed in either the formal or informal sectors.

The following behavioural variables were obtained by self-reporting; cigarette smoking, alcohol use, physical activity, and fruit and vegetables consumption patterns. Participants were questioned on their servings of fruit and vegetables daily. The smoking categories were; primary smokers (smoking directly), secondary smokers (if living with a smoker) or non-smoker. Physical activity levels of participants were obtained by self-reporting and categorized based on their engagement in moderate (yes/no) or vigorous intensity (yes/no) exercise leading to an increase in heart rate and respiratory rate, such as gardening.

Measurements

Blood pressure (systolic and diastolic) was measured in accordance with standard protocols[36] with a validated Microlife BP A100 Plus model. Hypertension was defined as an average of two systolic blood pressure of $\geq$ 140mmHg and diastolic of $\geq$ 90mmHg in accordance with the Eighth Joint National Committee (JNC 8) criteria. Participants who reported being informed of their hypertensive status by health professional(s) were considered aware. Uncontrolled hypertension among those on treatment with at least one or more anti-hypertensive medications was defined as systolic blood pressure greater than or equal to 140mmHg and diastolic blood pressure greater than or equal to 90mmHg, in accordance with JNC 8 criteria. The fasting blood glucose of each participant was measured with a validated ACCU-CHEK glucose monitoring apparatus in fasting state. Participants were diagnosed with diabetes if their fasting blood glucose level was equal or greater than 7.0 mmol/L or if they were on current medications for diabetes. They were defined as pre-diabetic if the fasting blood glucose fell between 6.1-6.9 mmol/L.[37]

Body weight was measured in light clothes to the nearest 0.01kg in the standing position using a Soehnle Scale (Soenle-Waagen Gmbh Co., Muurhardt, Germany) and height was measured to the nearest 0.1m by a stadiometer in standing position with closed feet (without shoes), holding their breath in full inspiration and Frankfurt line of vision.[38] Body mass index (BMI) was calculated as weight in kg divided by height in square metres (kg/m^2). BMI was categorized in accordance with WHO[39] as <18.5kg/m^2, 18.5-24.9kg/m^2, 25.5-29.9kg/m^2 and >30.0kg/m^2 as underweight, normal, overweight and obese, respectively.

Statistical analysis

Data were expressed as mean values ± standard deviations (SD) for continuous variables. Counts (frequencies=n) and proportions (%) were reported for categorical variables. A bivariate analysis was used to examine variables that have a significant association with hypertension and a p-value < 0.05 was considered statistically significant. The significant variables were included in the binary logistic regression and were adjusted for confounding factors. Analysis was carried out at a 95% confidence level. Statistical analysis was performed with the Statistical Package for Social Science (SPSS) version 21 for windows (SPSS Inc., Chicago, IL, USA).

Results

Our analysis was based on 988 participants with complete data responses; 321 were males and 677 were females (response rate, 92%). Eight percent of the participants were excluded from the study because of incomplete documentation of blood pressure, blood glucose, weight or height. More than half of the respondents – 56.5% of males and 60.2% of females – were between the ages of 18 and 45 years. With respect to income level, 69.4% of men and 80.9% of women, either had no source of income or earned less than R2000 per month. Table 1 provides the descriptive characteristics of the participants.

Table 1 Demographic characteristics of the participants by sex

Variables	Male (n=321) n(%)	Female (n=677) n(%)	Total (n=998) n(%)	p-value
Age group (years)				
18-25	40(12.5)	143(21.1)	183(18.3)	
26-35	74(23.1)	149(22.0)	223(22.3)	
36-45	67(20.9)	116(17.1)	183(18.3)	0.009
46-55	57(17.8)	110(16.2)	167(16.7)	
56-65	41(12.8)	99(14.6)	140(14.0)	
≥66	42(14.1)	60(8.9)	102(10.2)	
Level of education				
No formal schooling	62(19.3)	84(12.4)	146(14.6)	
Grade 1-7	57(17.8)	99(14.6)	156(15.6)	0.008
Grade 8-12	171(53.3)	409(60.4)	580(58.1)	
Tertiary	31(9.7)	85(12.6)	116(11.6)	
Monthly income (Rands)				
No income	134(41.7)	300(44.3)	445(44.6)	
R150-2000	89(27.7)	248(36.6)	326(32.7)	0.000
R2001-5000	74(23.1)	100(14.8)	174(17.4)	
R5001and above	24(7.5)	29(4.3	53(5.3)	
Marital status				
Single	193(60.3)	444(65.6)	637(63.9)	
Married	115(35.9)	185(27.3)	300(30.1)	
Separated	1(0.3)	5(0.7)	6(0.6)	0.002
Divorced	9(2.8)	13(1.9)	22(2.2)	
Widowed	2(0.6)	30(4.4)	32(3.2)	
Racial group				
Black	313(97.5)	666(98.4)	979(98.1)	
Coloured	8(2.8)	9(1.3)	17(1.7)	0.026
White	0(0.0)	2(0.3)	2(0.2)	
Type of employment				
Government employee	30(9.3)	33(4.9)	63(6.3)	
Non-government employment	98(30.5)	133(19.7)	231(23.2)	
Self-employment	30(9.3)	32(4.7)	62(6.2)	
Students	19(5.9)	80(11.8)	99(9.9)	0.000
Unemployed	115(35.8)	361(53.4)	476(47.7)	
Retired	29(9.0)	37(5.5)	66(6.6)	

Prevalence, awareness and treatment of hypertension

Of the 998 participants, 49.2% (n=491) were diagnosed with hypertension (Figure 1). Awareness of prior diagnosis of hypertension was reported by 339 participants (69.1% of total hypertensive individuals). Among those aware of having hypertension, nearly all (91.7%, n=311) were on anti-hypertensive medication. Treatment to target blood pressure occurred in 38.9% (n=121) of treated individuals.

Factors associated with hypertension

In bivariate analysis (Table 2), the following risk factors; ageing, male sex, lower level of education (below grade 8), being married, unemployed, lower income level, never drank

alcohol, sedentary lifestyle and both central and overall obesity were significantly associated with hypertension. Body mass index and age demonstrated positive linear associations with prevalent hypertension.

Table 2 Bivariate analysis showing the associated risk factors for hypertension

Variables	Hypertensive	Normal BP	RR	95% CI	p-value
Sex					
Male	175(54.5)	146(45.5)	1.4	1.0-1.8	0.012
Female	316(46.7)	361(53.3)			
Age (years)					
≤25	35(19.1)	148(80.9)	-	-	0.000
26-35	66(29.6)	157(70.4)			
36-45	72(39.3)	111(60.7)			
46-55	133(67.7)	54(32.3)			
56-65	117(83.6)	23(16.4)			
≥66	88(86.3)	14(13.7)			
Level of education					
No formal schooling	77(52.7)	69(47.3)			0.000
Grade 1 to 7	118(75.6)	38(24.4)			
Grade 8 to 12	250(43.1)	330(56.9)			
Tertiary	46(39.7)	70(60.3)			
Marital status					
Never married	251(39.4)	386(60.6)	0.4	0.3-0.5	0.000
Married	211(64.3)	117(35.7)			
Employment					
Government employee	33(52.4)	30(47.6)	-	-	0.000
Non-government employee	104(45.0)	127(55.0)			
Self-employed	29(46.8)	33(53.2)			
Student	18(18.2)	81(81.8)			
Unemployed	252(52.9)	224(47.1)			
Retired	54(81.8)	12(18.2)			
Monthly income					
R2000	222(62.2)	135(37.8)	1.9	1.4-2.7	0.000
≥R2001	105(46.3)	122(53.7)			
Ever drink alcohol					
Yes	131(41.1)	188(58.9)	0.6	0.5-0.8	0.000
No	359(53.7)	310(46.3)			
Moderate intensity physical activity					
Yes	256(45.6)	305(54.4)	0.7	0.6-0.9	0.006
No	234(53.8)	201(46.2)			
Vigorous intensity physical activity					
Yes	58(37.9)	95(62.1)	0.6	0.4-0.8	0.002
No	433(51.5)	412(48.8)			
Body mass index (kg/m^2)					
Underweight	12(37.5)	20(62.5)	-	-	0.000
Normal	89(33.0)	181(67.0)			
Overweight	106(45.3)	128(54.7)			
Stage 1 obesity	114(55.6)	91(44.4)			
Stage 2 obesity	84(60.9)	54(39.1)			
Stage 3 obesity	76(72.4)	29(27.6)			
Central obesity derived from waist-to-hip ratio					
Yes	268(56.8)	204(43.2)	0.6	0.4-0.7	0.000
No	221(42.3)	301(57.7)			
WC derived central obesity					
Obese	355(54.7)	294(45.3)	0.5	0.4-0.7	0.000
Not obese	135(38.9)	212(61.1)			

RR= Relative risk; CI= Confidence interval

In the multivariate logistic regression model analysis (Table 3), ageing, being married, male sex, concomitant diabetes mellitus, lower income level, being unemployed and central obesity were the significant and independent determinants of prevalent hypertension.

Table 3 Multivariate logistic regression analysis showing the predictors of hypertension

Variables	Beta	Wald	AOR (95% CI)	p-value
Age				
≤26 (Reference)				
Above 26	1.06	23.78	2.9(1.9-4.4)	0.005
Marital status				
Never married (Reference)				
Ever married	0.39	5.89	1.5(1.0-2.0)	0.015
Sex				
Female (Reference)				
Male	0.51	9.83	1.7(1.2-2.3)	0.000
Diabetes mellitus				
No (Reference)				
Yes	1.01	31.6	2.7(1.9-3.9)	0.000
Monthly income				
Middle-income >2000 (Reference)				
Low income ≤ 2000	0.49	9.48	1.6(1.2-2.2)	0.002
Employment				
Employed (Reference)				
Unemployed	0.33	4.01	1.4(1.0-1.9)	0.045
Central obesity derived from waist circumference				
No (Reference)				
Yes	0.63	10.0	2.1(1.5-2.8)	0.000

AOR=Adjusted odd ratios; CI= Confidence interval

Factors associated with hypertension awareness and control

Hypertension unawareness occurred in 152 participants with significant difference by sex (p=0.005). The following factors; male sex, lower age, higher level of education, single status, current employment status, higher income earners, current smokers, alcohol users, non-diabetic and non-obese individuals were associated with hypertension unawareness in the study (Table 4).

Table 4 Bivariate analysis showing the associated factors of hypertension awareness

Variables	Aware	Unaware	RR	95% CI	p-value
Sex					
Male	108(61.7)	67(38.3)	0.6	0.4-0.9	0.005
Female	232(73.4)	84(26.6)			
Age (years)					
<45	79(23.2.)	95(54.6)	0.5	0.1-0.3	0.000
>45	261(82.3)	56(17.7)			
Level of education					
No formal schooling	57(73.1)	21(26.9)	-	-	0.002
Grade 1-7	93(78.8)	25(21.1)			
Grade 8-12	168(67.2)	82(32.8)			
Tertiary	22(48.9)	23(51.1)			
Marital status					
Never married	152(60.6)	99(39.4)	0.5	0.3-0.7	0.000
Married	161(76.3)	50(23.7)			
Employment status					
Employed	99(59.3)	68(40.7)	0.5	0.3-0.7	0.000
Unemployed	241(74.4)	83(25.6)			
Monthly income (Rands)					
<R2000	276(71.7)	109(28.3)	1.7	1.1-2.6	0.018
>R2000	64(60.4)	42(39.6)			
Current smokers					
Yes	33(50.0)	33(50.0)	0.4	0.2-0.7	0.000
No	307(72.2)	118(27.8)			
Ever drink alcohol					
Yes	67(50.8)	65(49.2)	0.3	0.2-0.5	0.000
No	272(76.2)	85(23.8)			
Diabetes mellitus					
Yes	114(85.1)	20(14.9)			
No	226(63.3)	131(36.7)	0.3	0.2-0.5	0.000
Obesity					
Yes	260(73.4)	94(26.6)	2.5	1.5-3.2	0.001
No	79(58.1)	57(41.9)			

RR= Relative risk; CI= Confidence interval

Among the participants on treatment for hypertension (n=311), only level of education (no formal schooling) was associated with uncontrolled hypertension. Concomitant diabetes mellitus was not significantly associated with uncontrolled hypertension (Table 5).

Table 5 Bivariate analysis showing the factors associated with hypertension control

Variables	Controlled HTN	Uncontrolled HTN	RR	95% CI	p-value
Sex					
Male	34(35.4)	62(64.4)	0.8	0.5-1.3	0.262
Female	86(40.0)	129(60.0)			
Age (years)					
<45	31(47.7)	34(52.3)	1.6	0.9-2.8	0.061
>45	89(36.2)	157(63.8)			
Level of education					
No formal schooling	11(23.9)	35(76.1)	-	-	0.048
Grade 1-7	32(36.0)	57(64.0)			
Grade 8-12	68(43.0)	90(57.0)			
Tertiary	10(55.6)	8(44.4)			
Marital status					
Never married	56(42.4)	76(57.6)	0.8	0.5-1.2	0.165
Married	65(36.3)	114(63.7)			
Employment status					
Employed	36(41.4)	51(58.6)	0.9	0.5-1.4	0.344
Unemployed	85(38.1)	138(61.9)			
Monthly income (Rands)					
<R2000	98(38.9)	154(61.1)	1.0	0.6-1.8	0.551
>R2000	23(39.0)	36(61.0)			
Current smokers					
Yes	11(39.3)	17(60.7)	1.0	0.5-2.3	0.544
No	109(38.5)	174(61.5)			
Ever drink alcohol					
Yes	18(32.7)	37(67.3)	0.7	0.4-1.3	0.204
No	102(39.8)	154(60.2)			
Diabetes mellitus					
Yes	87(56.9)	66(43.1)	0.7	0.4-1.1	0.052
No	105(66.5)	53(33.5)			
Obesity					
Yes	76(36.8)	125(62.2)	0.9	0.6-1.5	0.398
No	44(40.0)	66(60.0)			

RR= Relative risk; CI= Confidence interval; HTN= Hypertension

Discussion

To the best knowledge of the authors, this is the first paper addressing epidemiological gaps regarding the prevalence, awareness, treatment and control of hypertension in the Buffalo City Metropolitan Municipality (BCMM). We found a high prevalence of hypertension (49.2%) in our study population. There seems to be an upward trend in the prevalence of hypertension in the country which is rather unsurprising, given rapid urbanization and its consequent effects on population health. Our result is higher than that in Day et al.'s [23] study, which reported a 40% prevalence of hypertension among South African adults in 2010. A lower prevalence of hypertension (38.9%) was reported by Peer et al.[25] among black urban South African adults between the ages of 24 and 65 years in Cape Town. A nationally representative house-hold survey in South Africa which included individuals aged 15 years and above reported a prevalence range of 9% in Limpopo Province to 22.3% in Northern

Cape Province.[34] The highest prevalence of hypertension (12.4%) was found among the black South African population. Weimann et al.[40] estimated a higher prevalence, at 37% and 52%, in the Eastern Cape and Northwest Provinces. The higher prevalence of 49.2% found among our sample is comparable to Northwest Province's 52%, but higher than the percentage reported for the Eastern Cape Province by Weimann et al.[40] with an almost similar age distribution. Our result was obtained from the primary health care setting and thus, may not be representative of the overall population. However, considering the age distribution of the study participants, with more than half below the of age 45, such a high prevalence of hypertension further signifies the need for urgent interventions as population ageing is often associated with a higher prevalence of hypertension.

There is a wide variation in the prevalence of hypertension across sub-Saharan Africa; from 23% among Zambian and Angolan adults to 26% in adults in four selected sub-Saharan African countries.[10-12,41] Akpan et al. [9] reported a prevalence of 48.3% among rural adults in the eastern part of Nigeria, while a 44.7% prevalence was documented among rural Ghanaian adults. Similar trends of increasing hypertension prevalence have been reported worldwide; Chow et al.[30] found a prevalence of 40.8% among rural and urban dwellers in selected high-income countries (Canada, Sweden, United Arab Emirates), middle-income countries (Argentina, Brazil, Chile, Poland, Turkey, Malaysia, South Africa, China, Colombia and Iran) and low-income countries (Bangladesh, India, Pakistan and Zimbabwe). A higher prevalence was reported in certain other developing countries, with prevalence ranging from 50.7% to 79.8% among adults living in urban areas of India, Latin America and China.[42,43] Our finding further supports the epidemiological shift of non-communicable diseases to developing nations.[13,44]

Although a thorough comparison of various studies cannot be done as a result of differences in the definitions, methodology and populations used, the findings from this study indicate that South Africa is already at the forefront of the epidemiologic transition. The shift is being exacerbated by advancements in technology attributed to urbanization and westernization. These are both the driving forces of the increasing burden of non-communicable disease risk factors of which hypertension is predominant. It is linked to the adoption of unhealthy lifestyle behaviours, poor dietary practices and poor engagement in physical activity, leading to obesity, and ultimately, cardiovascular risk factors like hypertension. Our findings signal a

looming burden of non-communicable disease among the study participants if urgent actions are not taken.

We found ageing, male sex, being married, unemployment status, poverty, sedentary lifestyles, obesity and diabetes mellitus as the important determinants of prevalent hypertension in the study population. Several other studies have also established a link between these risk factors. Pires et al.[12] affirmed that increasing age, lower level of education and increasing weight were associated with hypertension. Additionally, Guwatudde et al.[11] found diabetes to be significantly associated with hypertension. Increasing age is often associated with changes in the body systems, including the cardiovascular system such as the heart and arteries. Old people suffer a great deal of cardiovascular risk factors, especially hypertension.[45]

We found a higher prevalence of hypertension in individuals with a lower level of education (below grade 8). These individuals are most likely to be unemployed and to earn less than R2000 per month. The association between level of education and health is rather complex; it can be assumed that the more educated an individual is, the more knowledgeable he will be on matters of health. Whether this assumption is true in our study population is rather speculative. Cutler and Lleras-Muney[46] reported that education increases knowledge. Educated individuals are more likely to be receptive to new developments, including newly approved drugs, and are often compliant with drug use.[47,48] Our study participants with hypertension were poor and unemployed. Their socio-economic status limited their access to healthy foods and increased their consumption of readily available, cheap foods which contribute to risk factors such as obesity and hypertension. This should, however, be interpreted with caution, as being unemployed does not necessarily denote a low income. Underlying factors associated with unemployment, such as psychological stress, could contribute to the high prevalence of hypertension among this cohort. We found a higher prevalence of hypertension among men. Female hormonal effect is believed to be protective[49] and since the majority of the women in this study were below the age of 50, this could be a plausible reason for our findings. Also, obesity, work stress, physical inactivity, alcohol intake and salt intake have been reported to be high in men, resulting in higher odds of men developing hypertension.[50]

There is a substantial intersection between hypertension and diabetes because of the shared metabolic pathway and risk factors.[51-53] Hypertension is always found in more than half of individuals with type-2 diabetes and the chances of developing hypertension among persons with type-2 diabetes is more than double than that amongst non-diabetic persons.[54] Also, as shown by Murphy et al. and Bromfield & Munter,[55,56] there is a recognized link between hypertension, obesity, smoking, harmful use of alcohol and physical inactivity and a large percentage of the hypertension burden is attributed to these factors. The relationship between hypertension and obesity has long been established. Obesity increases the chance of developing hypertension and increases the risk of developing cardiovascular complications.[57,58] As reported by Pandey et al, [59] smoking increases the prevalence of hypertension.[53] Physical inactivity is a precursor to obesity and hypertension. Physical inactivity is responsible for 20% of hypertension cases.[60]

The present study further illustrates that the majority (69.1%) of the hypertensive patients were aware of their status, and of these, almost all (91.7%) were already on treatment with only 38.9% achieving control. This awareness rate is higher than the 24% awareness rate reported among South Asian adults.[61] There is a wide variation of hypertension awareness across African countries with rates ranging from 8% in Nigeria to 81% among elderly individuals in Tunisia.[62] Also, the study settings being health facilities might have contributed to the high awareness prevalence recorded in this study.

Despite scientific successes in anti-hypertensive drug discoveries, achieving treatment targets remains a serious challenge. Although nearly all of the participants with prior diagnosis were already receiving treatment for hypertension, a commendable effort, only 38.9% achieved treatment targets. This is somewhat better than previous studies conducted in Mthatha, South Africa (25.5%) and Zimbabwe, (32.8%).[22,31] It is also comparable to the rate of control of hypertension (36.4%) reported by Day et al.[23] in a household survey conducted among South African adults in 2010. Generally, hypertension control has been reported to be sub-optimal in Africa, ranging from 2.6% in Kenya to 42.2% in Ethiopia.[62-64]

We observed that men, those earning more than R2000 per month, those aged under 45 years, employed, cigarette smokers and alcohol users had higher rates of hypertension unawareness. Men have been reported to have higher odds of developing hypertension and the high rate of unawareness among them is not surprising. Females have been recognized as more likely to

seek healthcare than men.[65] Traditional gender roles in Africa account for the under-utilization of health facilities among men; men are the breadwinners and are perceived as healthy.[66,67] Hence, they rarely seek health facilities for screening purposes unless they are sick. Hypertension is largely asymptomatic and this being the case, an affected individual will rarely seek healthcare. Our findings have serious public health consequences, due to the clustering of cardiovascular diseases among the individuals with hypertension unawareness. Younger individuals are unlikely to visit health facilities without any major sickness. Hence the high rate of unawareness in those younger than 45 years. Besides, this cohort of individuals are pre-occupied by their jobs. Older individuals tend to have multi-morbidity and as such, would have had several opportunities to be screened for non-communicable diseases. Alcohol-and nicotine-dependence may explain our findings of high unawareness among alcohol users and current cigarette smokers, respectively.

We found a high rate of uncontrolled hypertension (62.4%) in our study participants. Several factors have been implicated for the poor control of hypertension in Africa, which are generally related to deficiencies in the healthcare system, non-adherence to medication regimens by patients and physicians' inertia to optimize treatment of hypertension.[22,62] Several studies have documented the unavailability of anti-hypertensive drugs as well as non-adherence to clinic visits by patients as a result of lack of transportation and time.[12,68,69] Poor treatment outcomes in Africa has been documented extensively.[13,31,62,70,71] In comparison, higher levels of control (64.8% and 66%) of hypertension were reported in the USA and Canada, respectively.[72,73] This is not a surprise as the management of hypertension is costly due to its chronic nature. Developed countries have been recording successes in the reduction of the burden related to hypertension and other non-communicable diseases.[74]

Also, participants who had diabetes mellitus were found to have a lower rate of controlled hypertension. Multi-morbidity with significant risks of poly-pharmacy are some of the reasons for the poor control of blood pressure in those with concomitant diabetes. A study in a similar setting by Adeniyi et al.[22] found poor control of blood pressure among individuals with concomitant diabetes. Illiteracy was associated with poor blood pressure control among our study participants already on treatment for hypertension. Poor treatment outcomes among individuals with no formal education is not surprising. Despite the availability of medications at the health facility, some of our patients regularly miss appointments and fail to collect medications. Education is said to be "power" and Cutler and Lleras-Muney[46] assert that education increases knowledge. There is a possibility of a lack of adequate knowledge on the

importance of medication use in the control of hypertension among illiterate persons. In addition, the benefits of positive lifestyle behaviours for the control of hypertension might not be fully appreciated by such individuals. Likewise, lack of education generally leads to poverty; thus poorly educated patients are less likely to be able to purchase essential drugs for hypertension or to eat as healthily, as healthy foods tend to cost far more low-cost, carbohydrate-rich foods.[75]

Strengths and limitations

The limitations of the study cannot be ignored. Firstly, this was a cross-sectional study, hence causality cannot be ascribed to the determinants. Our findings should be interpreted with caution in view of the convenience sampling of the participants at the primary health care facilities. We also did not obtain information on the hypertensive medications being used and therefore, could not gain a full understanding of the uncontrolled hypertension in our study participants. Notwithstanding these limitations, the findings of the study provide useful epidemiological data in view of the large sample size, the large out-patient clinics selected and the previously understudied setting.

CONCLUSION

The findings of a high prevalence of hypertension and sub-optimal blood pressure control of hypertension requires the urgent attention of health authorities in Buffalo City Metropolitan Municipality. Also, the clustering of cardiovascular risk factors in individuals with hypertension suggests that an integrated strategy addressing all the non-communicable diseases will be needed to mitigate the looming epidemic. Strategies aimed at the prevention of hypertension, its early diagnosis and treatment to target blood pressure levels are needed in BCMM. Also, the re-engineering of the primary health care system will be crucial towards dealing with the burden of non-communicable diseases in the region.

Consent for publication

All authors approved the submission of this final draft towards publication in a peer reviewed journal.

Availability of data and materials

Data from this study will be made available on request.

Competing interests

The authors declare no conflict of interest.

Funding

EOO received master's study grants from the National Research Foundation and the Health and Welfare Sector Education and Training Authority, South Africa towards the implementation of the project.

Authors' contributions

EOO, DTG and OVA conceptualised, designed and drafted the paper. ES participated in data collection and gave intellectual contribution into the manuscript. All authors read and approved the final manuscript.

Acknowledgements

The authors are grateful to the management and the nursing staff of the three health facilities for their support towards the successful implementation of the project.

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Figure 1: Prevalence of Hypertension

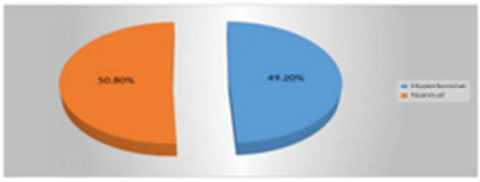

Figure 1: Prevalence of Hypertension

Figure 1. Prevalence of Hypertension

30x30mm (300 x 300 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract. – Page 1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found – Page 2
Introduction		
Background/rationale-pg	2	Explain the scientific background and rationale for the investigation being reported – page 3 to 4
Objectives	3	State specific objectives, including any pre-specified hypotheses – Page 4
Methods		
Study design	4	Present key elements of study design early in the paper – Page 4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection – Page 4 to 7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants – Page 4 to 5
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable – Page 6 to 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 – Page 6 to 7
Bias	9	Describe any efforts to address potential sources of bias
Study size	10	Explain how the study size was arrived at – Page 4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why – Page 7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding – Page 7
		(*b*) Describe any methods used to examine subgroups and interactions
		(*c*) Explain how missing data were addressed
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy – Page 7
		(*e*) Describe any sensitivity analyses

Continued on next page

Results – Pg 7		
Participants	13*	(a) 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
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders – Page 7 to 8
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results	16	(*a*) 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 – Page 8 to 12.
		(*b*) Report category boundaries when continuous variables were categorized. Page 8 to 12
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives – Page 12 to 17
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 – Page 17
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence – Page 17
Generalisability	21	Discuss the generalisability (external validity) of the study results – Page 17
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 – Page 18

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.