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# Noncommunicable disease risk factors and predictors of hypertension among Gurkha veterans in Nepal: a community-based cross-sectional study

Nilam Adhikari<sup>1\*</sup>, Krishna Prasad Sapkota<sup>2</sup>, Sagar Panthi<sup>3</sup>, Rochana Acharya<sup>4</sup>, Madhav Bhusal<sup>5</sup>, Sangita Bhattarai<sup>6</sup>, Gampo Dorji<sup>7</sup>, Shyam Sundar Budhathoki<sup>1</sup>, Dharanidhar Baral<sup>1</sup> and Paras K. Pokharel<sup>1</sup>

## Abstract

**Background** Nepal faces a rising burden of noncommunicable diseases (NCDs), yet Gurkha veterans—a population with distinct sociocultural backgrounds, occupational exposures, and post-service lifestyle transitions; remain largely overlooked in NCD research. Their increased susceptibility to sedentary behavior and unhealthy dietary habits may contribute to heightened NCD risks. This study assesses key behavioral (smoking, alcohol use, diet, and physical inactivity) and metabolic (obesity, elevated blood pressure) risk factors and identifies predictors of hypertension among Gurkha veterans.

**Methods** A community-based cross-sectional study was conducted in Palpa district, Lumbini Province, Nepal, in 2019. A multistage sampling technique was employed to determine the sample size, and a total of 189 Gurkha veterans were interviewed for data collection. Data were analyzed using SAS software (Version 9.4). A Bivariate analysis was conducted to assess the statistical associations among NCD risk factors, followed by multivariable logistic regression to identify independent predictors of hypertension while controlling for potential confounders.

**Results** The study revealed a high prevalence of daily alcohol consumption (41.80%), and inadequate fruit intake (89.95%). Likewise, 28.57% of the Gurkha veterans had lower intake of vegetables and 26.98% of them were performing low physical activity of vigorous level. Moreover, 35.98% had overweight and obesity and, nearly half of the participants (47.62%) were hypertensive. Multivariable logistic regression showed that daily alcohol drinkers (AOR: 3.13, 95% CI: 1.56–6.25,  $p=0.001$ ), those engaging in less than 75 minutes per week of vigorous physical activity (AOR: 4.82, 95% CI: 1.89–12.30,  $p=0.001$ ), and those with overweight or obese status (AOR: 3.50, 95% CI: 1.70–7.22,  $p<0.001$ ) had significantly higher odds of having hypertension.

**Conclusion** Alcohol consumption, physical inactivity, and obesity were the strongest predictors of hypertension among ex-Gurkha soldiers. Given the distinct lifestyle transitions and health challenges faced by this population, targeted early screening, at the community level with a continuum of care and health promotion strategies are essential to mitigate the NCD burden among retired Gurkha soldiers.

**Keywords** Veterans, Ex-Gurkhas, Noncommunicable disease, Hypertension, Nepal

\*Correspondence:

Nilam Adhikari  
nilam.adhikari05@gmail.com

Full list of author information is available at the end of the article



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## Introduction

Young Nepali adults have been serving in the British Army since the conclusion of the Anglo-Nepali War (1812–1815 AD) [1]. These soldiers, known as “*Gurkhas*”, are renowned for their exceptional infantry skills, bravery, and resilience [2]. The term “*Gurkhas*” specifically refers to a legendary group of highly skilled warriors predominantly recruited from selected hill ethnic groups, including the Magar, Gurung, Rai, and Limbu communities of Nepal. Over the years, Gurkhas have served in the armed forces of the United Kingdom, India, and Singapore, participating in major global conflicts, including World War I and World War II [3, 4]. Upon retirement, they are referred to as ex-Gurkha or Gurkha veterans or “*Lahure*” in the Nepali language. Most return to Nepal with pensions and are held in high regard within their communities [5].

Despite their history of rigorous physical training and military discipline, ex-Gurkhas face a heightened risk of noncommunicable diseases (NCDs) after retirement [6, 7]. This increased vulnerability can be attributed to several factors, including lifestyle transitions, reduced physical activity, unhealthy dietary habits, heightened stress levels, increased alcohol consumption, and limited access to healthcare services [8–10]. The unique working environment of military personnel, characterized by high-risk conditions and occupational stress, presents cumulative inequality in NCD risk [11]. Studies suggest that the demanding nature of military service places veterans at a greater risk of developing behavioral and metabolic risk factors for NCDs [12, 13]. Moreover, the transition from active military duty to civilian life presents challenges, including adapting to new routines and adopting healthy habits [14].

Globally, NCDs account for approximately 41 million deaths annually, representing 74% of all deaths worldwide, with a disproportionate burden (32 million deaths) occurring in low- and middle-income countries (LMICs) [15]. Among veterans, lifestyle and health-related factors play a crucial role in shaping long-term health outcomes, particularly in cognitive and cardiometabolic aging [16]. A prior global study on military populations reported an overall prevalence of obesity at 14% and hypertension at 26% [17]. While Western military veterans often experience a higher burden of NCDs [18], they generally benefit from better healthcare access compared to ex-Gurkhas, who face significant post-service health disparities. Studies indicate that ex-Gurkhas encounter barriers to healthcare access, underrepresentation in research, and challenges in utilizing clinical services, making them a particularly vulnerable group [19]. Furthermore, multiple studies in Nepal have highlighted a high prevalence of hypertension among war veterans [6, 7].

The growing burden of NCDs in Nepal is evident from national surveys, which report increasing trends in metabolic risk factors (e.g., elevated cholesterol and glucose levels) and behavioral risk factors (e.g., tobacco use, alcohol consumption, physical inactivity, and poor diet) [20]. Despite this, Nepal's healthcare system, including the national health insurance program, remains ill-equipped to address the rising incidence of cardiovascular diseases such as hypertension at both primary and specialty care levels [21].

Numerous studies have investigated NCD risk factors in Nepal; however, they often overlook special populations such as ex-Gurkhas, whose unique socio-cultural backgrounds, occupational exposures, and post-service transitions may accelerate the development of NCD risk profiles. Having represented Nepal as some of the most fearless and skilled warriors in international conflicts, their health vulnerabilities remain largely understudied.

Unlike the general civilian population or civil servants, ex-Gurkhas undergo significant lifestyle changes in post-retirement period, often experiencing a shift toward sedentary behavior, dietary changes (including increased consumption of processed foods), smoking, and alcohol consumption. These factors may heighten their susceptibility to NCDs; however, there is limited research specifically examining their health status within the context of Nepal.

Therefore, this study has two key objectives: first, to explore the prevalence of NCD risk factors, including behavioral (smoking, alcohol consumption, unhealthy diet, and physical inactivity) and metabolic (overweight/obesity and elevated blood pressure) risk factors among ex-Gurkha soldiers in Nepal; second, to identify the predictors of hypertension within this population.

## Methods

A community-based cross-sectional study was conducted in Mathagadhi Rural Municipality, located in the Palpa district of Lumbini Province, Nepal, between March 1 to August 31, 2019. Nepal has a substantial population of retired Gurkha soldiers, with approximately 3,812 British Gurkhas and 126,000 Indian Gurkhas currently residing in the country. The majority of these veterans are concentrated in cities such as Dharan, Pokhara, Butwal, Syangja, and Palpa [22, 23].

Mathagadhi Rural Municipality, a local government unit in western Nepal's Palpa district, has a population of 12,802, with a significant proportion belonging to the Magar community [24]. The Magar people primarily rely on agriculture, military service, and foreign employment as their main sources of income. They also represent a substantial number of Gurkha soldiers serving outside Nepal [25].

### Sample size and sampling technique

Cochran's formula [ $n = \{Z^2 p(1-p)\}/e^2$ ] was used to determine the sample size, where  $n$  represents the required sample size,  $Z$  is the test statistic at a 95% confidence interval (CI),  $p$  denotes the proportion of the condition, and  $e$  is the desired level of precision, set at 10% of  $p$ . The proportion of low fruit and vegetable consumption (61.9%) was chosen as the specific variable of interest for assessing risk factors for NCDs [26]. Based on this calculation, the required sample size was 189, with an additional 10% adjustment to account for potential nonresponse.

A multistage sampling technique was employed in this study. First, Mathagadhi Rural Municipality was purposively selected as the study site. Subsequently, a simple random sampling method was used to select three out of the eight wards within the municipality. Within these selected wards, the probability proportional to size (PPS) sampling method was applied to determine the sample size for each ward based on the total number of ex-Gurkhas. Finally, within each ward, study participants were randomly selected using a simple random sampling technique. The detailed flowchart is shown in Fig. 1.

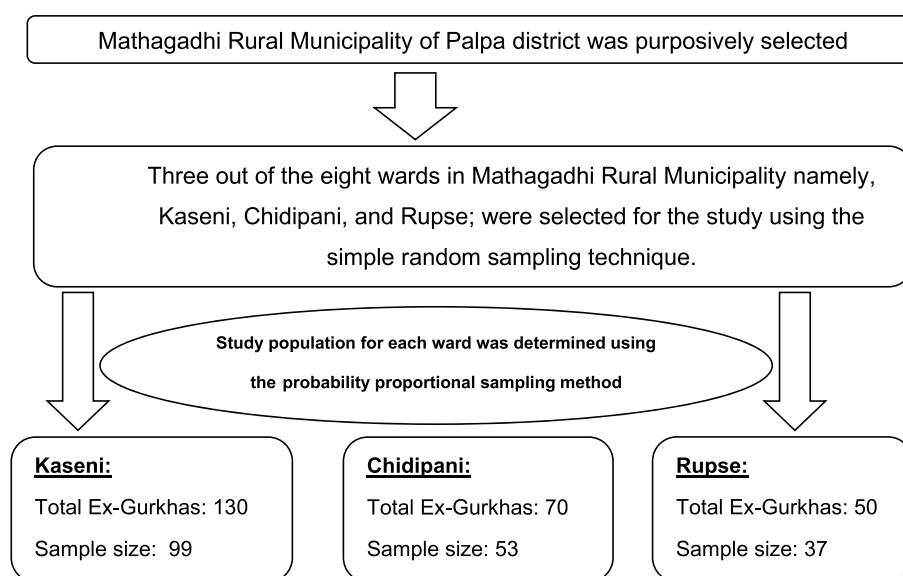
This study included ex-Gurkha soldiers who had retired from active military service from Indian Gurkha units, provided they had served for a minimum of 10 years and had given informed consent to participate. Individuals with significant psychiatric illness,

substance abuse, or other conditions that could affect their participation were excluded. The study population comprised ex-Gurkhas from various regiments, including the 1st to 10th Gurkha Rifles and other border security forces.

The questionnaire used in this study was adapted from the standardized WHO STEPwise approach to NCD risk factor surveillance (STEPS) survey for NCD risk factor assessment and was further supplemented with military-specific variables [27]. It covered key domains such as demographics, self-reported health status, dietary habits, tobacco and alcohol use, physical activity, and NCD history. (Supplementary file 1).

Face-to-face interviews were conducted in the participants' homes by the first author. In addition to the interviews, anthropometric and clinical measurements were taken by the first author using standard equipment, following the protocols recommended by the WHO STEPS methodology [28].

To ensure the validity and reliability of the data collection tool, a pretest was conducted in Dharan Sub-Metropolitan City, Eastern Nepal, involving 20 individuals (10% of the total sample). Necessary modifications were made based on linguistic and contextual feedback to enhance accuracy. Additionally, content validation was performed by experts from the School of Public Health and Community Medicine, BP Koirala Institute of Health Sciences, Dharan, Nepal. These measures ensured the tool's appropriateness, validity, and reliability for the study population.



**Fig. 1** Sampling technique

## Measurements

Various physical measurements were taken to assess the participants' health status during the study. Blood pressure was measured using a CITIZEN Digital Blood Pressure Measuring Device (CH-453 AC). To ensure accuracy, participants were asked to rest for at least five minutes before the measurement. Three readings were taken at three-minute intervals, and the mean of these readings was used for analysis, following standard blood pressure measurement guidelines [29].

Anthropometric measurements included height, weight, waist circumference, and hip circumference. Height (in centimeters) was measured using a portable stature meter, while weight (in kilograms) was recorded using a digital weighing scale. Participants were instructed to remove their footwear and socks, wear light clothing, stand upright with their arms at their sides, and look straight ahead while the measurement was taken.

Waist and hip circumferences were measured using a constant tension tape over light clothing in a private setting. Waist circumference was recorded at the midpoint between the last palpable rib and the top of the hip bone at the end of a normal expiration. Hip circumference was measured at the widest part of the buttocks, ensuring that the tape remained snug but not compressing the skin. All measurements were recorded to the nearest 0.1 cm for precision.

## Operational definitions

Age was categorized into two groups: middle-aged adults (below 60 years) and older adults (60 years and above). Educational attainment was classified into three distinct levels: Below Primary (grades below Class 5), Primary (Classes/grades 5 to 8), and Secondary (Classes/grades 9 and 10, equivalent to the School Leaving Certificate or Secondary Education Examination). Service duration was measured based on the total years served in the Gurkha regiment and categorized into less than 20 years and 20 years or more. Additionally, the final rank (position) held by ex-Gurkhas before retirement was recorded and grouped into below officer and officer or higher.

Alcohol consumption status was categorized into two groups: ever alcohol consumed and daily alcohol consumed, with yes/no responses [27]. Smokeless tobacco referred to non-combustible forms of tobacco, including chewing products such as *khaini*, *surti*, and *gutkha*. A current tobacco consumer was defined as an individual who had smoked or chewed tobacco products within the past 30 days [27]. Likewise, ever smoked was also measured by asking whether Gurkha veterans smoked in their lifetime. Insufficient physical activity was defined as engaging in less than 75 minutes per week of vigorous-intensity exercise or less than 150 minutes per week of

moderate-intensity exercise, in accordance with WHO guidelines [30]. Participants who consumed fewer than five servings of fruits and vegetables per day were classified as having insufficient fruit and vegetable intake [31]. Body mass index (BMI) was calculated as weight (kg) divided by height ( $m^2$ ) and classified according to WHO standards: underweight ( $<18.5 \text{ kg}/m^2$ ), normal weight ( $18.5\text{--}24.9 \text{ kg}/m^2$ ), overweight ( $25.0\text{--}29.9 \text{ kg}/m^2$ ), and obese ( $\geq 30.0 \text{ kg}/m^2$ ) [32]. Central obesity was defined based on the WHO waist-to-hip ratio criteria, with a ratio above 0.90 indicating abdominal obesity in males [33]. Diabetes status was determined based on a self-reported yes/no response.

Blood pressure (BP) classification followed the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure (JNC VII). It was categorized as follows: Normal (systolic BP  $<120 \text{ mmHg}$  and diastolic BP  $<80 \text{ mmHg}$ ), Prehypertension (systolic BP  $120\text{--}139 \text{ mmHg}$  or diastolic BP  $80\text{--}89 \text{ mmHg}$ ), Stage 1 Hypertension (systolic BP  $140\text{--}159 \text{ mmHg}$  or diastolic BP  $90\text{--}99 \text{ mmHg}$ ), and Stage 2 Hypertension (systolic BP  $\geq 160 \text{ mmHg}$  or diastolic BP  $\geq 100 \text{ mmHg}$ ) [30]. Moreover, for the logistic regression analysis, it was binarized as Normotensive (Normal and Prehypertension) and Hypertensive (Stage 1 and 2 Hypertension).

## Statistical analysis

The collected data were compiled, edited, and checked for consistency using Microsoft Excel 2016 before being transferred to SAS software version 9.4 (SAS Institute Inc., 2013, Cary, NC) for further analysis. Descriptive statistics, including frequency distributions with numbers and percentages, were used to summarize the data.

Bivariate analysis was conducted to examine associations between NCD risk factors and hypertension. Multivariable logistic regression was performed to further assess the relationships between behavioral and metabolic risk factors and hypertension while controlling for sociodemographic characteristics. The regression results are presented as adjusted odds ratios (AORs) with 95% confidence intervals (CIs), and a p-value of less than 0.05 was considered statistically significant.

Multicollinearity was assessed using the variance inflation factor (VIF). Moderate physical activity exhibited collinearity with vigorous physical activity and was therefore excluded from the regression model. After removing this variable, all remaining predictors had VIF values below 2.5, indicating no significant multicollinearity issues. Additionally, the concordance statistic (c-statistic) of the regression model was 0.787, suggesting that the model had good explanatory power. The goodness of fit of the model was checked with

Hosmer and Lemeshow Goodness-of Fit Test where chi-square value was 11.24, degree of freedom of 8 and  $p$ -value of 0.188. These fit statistics suggest that the model was fit as chi-square was not significant.

## Results

### Sociodemographic characteristics of ex-Gurkha soldiers

Table 1 presents the sociodemographic characteristics of the participants. Nearly two-thirds (62.96%) were older adults (aged 60–95 years), while approximately one-third (36.52%) had not attained a primary level of education. More than half (57.14%) had served in the military for less than 20 years. The majority (75.13%) retired as noncommissioned officers. Similarly, a significant proportion (71.40%) had direct involvement in wars and insurgencies, and over half (64.02%) had participated in international conflicts.

### Situation of risk factors for NCDs among ex-Gurkha soldiers

Table 2 presents the overall prevalence of NCD risk factors among ex-Gurkha soldiers:

#### Smoking

More than one-tenth (12.7%) of the participants were current smokers, with an average initiation age of 38.25 years (range: 13–73 years). Additionally, 19% reported a history of smoking, and more than half had attempted to quit in the past.

#### Alcohol consumption

Nearly all respondents (98.4%) had consumed alcohol at some point in their lives, with 82.53% reporting alcohol consumption within the past few months. Almost half (41.8%) consumed alcohol daily.

### Fruit and vegetable consumption

The majority (89.95%) consumed fewer than the recommended five servings of fruit per day, while 28.57% fell short of the recommended vegetable intake.

Physical activity: Most respondents (73.01%) met the WHO guideline of at least 75 minutes of vigorous-intensity exercise per week. Additionally, 78.31% engaged in a minimum of 150 minutes of moderate-intensity exercise per week.

### Blood pressure measurement

Nearly half (47.62%) of participants were classified as hypertensive, while 32.8% fell into the prehypertensive category.

### Body mass index

Over one-third (35.98%) of respondents were classified as overweight or obese.

### Diabetes

Approximately one-tenth (11.64%) of the ex-Gurkhas soldiers self-reported having diabetes.

### Waist-to-hip ratio

Central obesity, a strong predictor of type II diabetes and other NCDs, was prevalent among one-third (32.28%) of the veterans.

### Predictors of hypertension among ex-Gurkha soldiers

Tables 3 presents the results of the bivariate analysis examining the associations between predictive variables and hypertension status among the study population. The chi-square analysis revealed statistically significant associations between hypertension and various risk factors, including: ever alcohol consumption ( $\chi^2(1)=23.79$ ,  $p<0.001$ ), daily alcohol consumption ( $\chi^2(1)=18.03$ ,  $p<0.001$ ), less fruit consumption ( $\chi^2(1)=5.98$ ,  $p=0.014$ ), less vegetable consumption ( $\chi^2(1)=5.41$ ,  $p=0.019$ ), lack of vigorous physical activity ( $\chi^2(1)=14.77$ ,  $p<0.001$ ),

**Table 1** Socio demographic characteristic of ex-Gurkha soldiers ( $n=189$ )

Socio demographic characteristics		Frequency (n)	Percent (%)
Age	Middle-aged adults	70	37.04
	Older adults	119	62.96
Educational Level	Below primary	69	36.52
	Primary	71	37.57
	Secondary	49	25.93
Service years	Less than 20 years	108	57.14
	20 years and more	81	42.85
Position	Non-commissioned officer	142	75.13
	Commissioned officer and above	47	24.87



**Table 2** Prevalence of NCDs risk factors among ex-Gurkha soldiers (n=189)

Variables	Characteristics	Categories	n	%
Behavioral risk factors for NCDs				
Tobacco and tobacco products	Current Tobacco Consumption	Yes	24	12.70
		No	165	87.3
	Ever smoked	Yes	36	19.05
		No	153	80.95
Alcohol Consumption	Ever alcohol consumption	Yes	187	98.95
		No	2	1.05
	Daily alcohol consumption	Yes	79	41.80
		No	110	58.20
Fruits consumption	Servings per day	Less than five	170	89.95
		Five or more than five	19	10.05
Vegetables consumption	Servings per day	Less than five	54	28.57
		Five or more than five	135	71.43
Physical activity	Vigorous physical activity	< 74 min per week	51	26.98
		≥ 75 min per week	138	73.02
	Moderate physical activity	< 159 min per week	41	21.69
		≥ 150 min per week	148	78.31
Metabolic risk factors for NCDs				
Raised in blood pressure	Blood pressure measurement	Normotensive	99	52.38
		Hypertensive	90	47.62
BMI		Normal	121	64.02
		Overweight and obese	68	35.98
Waist hip ratio		Normal	128	67.72
		Overweight and obese	61	32.28

n frequency, NCDs Noncommunicable diseases, BMI Body Mass Index

moderate physical activity ( $\chi^2(1)=6.98$ ,  $p=0.008$ ), overweight and obesity based on BMI ( $\chi^2(1)=8.52$ ,  $p=0.003$ ), and overweight and obesity based on a waist-hip ratio ( $\chi^2(1)=4.69$ ,  $p<0.03$ ).

A significantly higher proportion of ex-Gurkhas who had ever consumed alcohol were hypertensive (55.77%) compared to those who had never consumed alcohol (9.09%). Similarly, 65.82% of daily alcohol consumers had hypertension, while only 34.55% of non-daily alcohol consumers were hypertensive.

A majority (50.59%) of ex-Gurkhas consuming fewer than five servings of fruit per day had hypertension, compared to 21.05% of those consuming five or more servings daily. Likewise, hypertension was more prevalent (61.11%) among those consuming fewer than five servings of vegetables per day compared to those who met the recommended intake (42.22%).

Physical activity levels were also significantly associated with hypertension. A higher percentage of ex-Gurkhas engaging in less than 75 minutes of vigorous physical activity per week (70.59%) had hypertension compared to those engaging in 75 minutes or more per week (39.13%).

Similarly, among those performing less than 150 minutes of moderate physical activity per week, 65.85% had hypertension, whereas 42.57% of those meeting the recommended threshold were hypertensive.

Obesity-related factors showed a notable association with hypertension. A majority of ex-Gurkhas classified as overweight or obese based on BMI (61.79%) had hypertension, compared to 39.67% of those in the normal BMI range. Similarly, 59.02% of those with a high waist-to-hip ratio had hypertension, whereas only 42.19% of those with a normal ratio were hypertensive.

Multivariable logistic regression was performed to identify the predictors of hypertension (Table 4). After controlling for other behavioral and metabolic risk factors as well as sociodemographic characteristics, daily alcohol drinkers were found to have significantly higher odds of having hypertension compared to those who did not consume alcohol daily (AOR: 3.13, 95% CI: 1.56–6.25,  $p = 0.001$ ).

Participants who engaged in less than 75 minutes per week of vigorous physical activity were 4.82 times more likely to develop hypertension (AOR: 4.82, 95% CI: 1.89–12.30,  $p = 0.001$ ). Furthermore, veterans

**Table 3** Bivariate results on association of socio-demographic characteristics, behavioral and metabolic risk factors of NCDs with hypertension among ex-Gurkha soldiers

Variables	Characteristics	Hypertension		χ2 value	p-value
		Normotensive (n=99, 52.38%)	Hypertensive (n=90, 47.62%)		
Socio-demographic variables					
War Involvement	Involved	67 (49.63)	68 (50.37)	1.43	0.231
	Noninvolved	32 (59.23)	22 (40.74)		
Position	Officer and above	26 (55.32)	21 (44.68)	0.22	0.642
	Less than officer	73 (51.41)	69 (48.59)		
Service Year	≥ 20 years	50 (46.30)	58 (53.70)	3.74	0.053
	< 20 years	49 (60.49)	32 (39.51)		
Age	Middle-aged adults	42 (60.00)	28 (40.00)	2.59	0.108
	Older adults	57 (47.90)	62 (52.10)		
Education	Below Primary	30 (43.48)	39 (56.52)	4.56	0.102
	Primary school	38 (53.52)	33 (46.48)		
	Secondary	31 (63.27)	18 (36.73)		
Behavioral risk factors of NCDs					
Current tobacco consumptions	Yes	11 (45.83)	13 (54.17)	0.47	0.492
	No	88 (53.33)	77 (46.67)		
Ever smoked	Yes	20 (55.56)	16 (44.44)	0.18	0.672
	No	79 (51.63)	74 (48.37)		
Ever alcohol consumption	Yes	69 (44.23)	87 (55.77)	23.79	<0.001
	No	30 (90.91)	3 (9.09)		
Daily alcohol consumption	Yes	27 (34.18)	52 (65.82)	18.03	<0.001
	No	72 (65.45)	38 (34.55)		
Fruits consumption	Less than five servings a day	84 (49.41)	86 (50.59)	5.98	0.014
	Five or more servings a day	15 (78.95)	4 (21.05)		
Vegetables consumption	Less than five servings a day	21 (38.89)	33 (61.11)	5.41	0.019
	Five or more servings a day	78 (57.78)	57 (42.22)		
Physical Activity	Vigorous			14.77	<0.001
	< 75 minute per week	15 (29.41)	36 (70.59)		
	≥ 75 minute per week	84 (60.87)	54 (39.13)		
	Moderate			6.98	0.008
	< 150 minute per week	14 (34.15)	27 (65.85)		
	≥ 150 minute per week	85 (57.43)	63 (42.57)		
Metabolic risk factors of NCDs					
Body mass index	Normal	73 (60.33)	48 (39.67)	8.52	0.003
	Obese	26 (38.24)	42 (61.76)		
Waist hip ratio	Normal	74 (57.81)	54 (42.19)	4.69	0.030
	Obese	25 (40.98)	36 (59.02)		
Diabetes	Present	9 (40.91)	13 (59.09)	1.31	0.252
	Absent	90 (53.89)	77 (46.11)		

 $\chi^2$  Chi-squared

classified as obese had 3.50 times greater odds of having hypertension compared to those with a normal BMI (AOR: 3.50, 95% CI: 1.70–7.22,  $p < 0.001$ ).

## Discussion

Assessing the risk factors for NCDs and the predictors of hypertension among ex-Gurkha soldiers is crucial,

**Table 4** Multivariable analysis showing the predictors of hypertension among the ex-Gurkha soldiers

Characteristics	Categories	Adjusted Odds Ratio (AOR)	95% CI	p-value
War involvement	Not involved	Ref		
	Involved	1.29	0.57–2.95	0.537
Position	Non-commissioned officer	Ref		
	Commissioned officer and above	0.83	0.27–2.50	0.739
Age	Middle-aged adults	Ref		
	Older adults	0.82	0.36–1.88	0.641
Education	Secondary school	Ref		
	Below Primary school	1.89	0.56–6.40	0.306
	Primary school	1.50	0.50–4.50	0.472
Current tobacco consumption	No	Ref		
	Yes	1.37	0.37–5.09	0.637
Ever smoked	No	Ref		
	Yes	0.41	0.13–1.29	0.128
Daily alcohol consumption	No	Ref		
	Yes	3.13	1.56–6.25	0.001
Fruits consumption	Five or more serving a day	Ref		
	Less than 5 serving a day	2.64	0.66–10.48	0.168
Vegetables consumption	Five or more serving a day	Ref		
	Less than 5 serving a day	0.96	0.41–2.21	0.918
Vigorous Physical Activity	≥ 75 minute per week	Ref		
	< 75 minute per week	4.82	1.89–12.30	0.001
Body mass index	Normal	Ref		
	Obese	3.50	1.70–7.22	<0.001
Waist-hip ratio	Normal	Ref		
	Obese	1.52	0.60–3.85	0.382
Diabetes	Absent	Ref		
	Present	1.15	0.32–4.21	0.827

Ref Reference group, CI confidence interval

particularly given the global increase in NCD incidence and the ongoing shifts in epidemiological determinants. This study reveals several behavioral and metabolic risk factors associated with hypertension among ex-Gurkhas, including alcohol use, low intake of fruits and vegetables, and insufficient physical activity. Additionally, metabolic risk factors such as obesity was significant contributors to hypertension.

#### Behavioral and metabolic risk factors

Our study found that 12.7% of participants were current smokers, which aligns with similar findings from a study among U.S. veterans [34]. However, this rate was lower than that of another study among veterans in a comparable setting, which reported a 17% current

smoking prevalence [35]. The cultural stigma against cigarette smoking in Nepal may have contributed to underreporting of smoking behaviors in our study.

The prevalence of alcohol consumption was particularly striking. Nearly all ex-Gurkha soldiers (98.94%) had consumed alcohol at some point in their lives, with 82.53% identified as current drinkers. This finding mirrors studies among military personnel, such as a U.S. study showing a 70% alcohol consumption rate among veterans deployed to Iraq and Afghanistan [36]. Alcohol plays a significant role in Nepalese social and religious customs, contributing to the higher prevalence of alcohol use among ex-Gurkhas. These cultural practices, coupled with social gatherings and family-oriented celebrations, amplify alcohol consumption



and subsequently increase the risk of hypertension and other NCDs. This study addresses a gap in the limited existing literature by highlighting the prevalence of alcohol use in this population, especially given that the findings of the “STEPS” survey estimate alcohol consumption at 38.6% among the male population [26].

Notably, 89.95% of participants in our study failed to meet the recommended intake of fruits and vegetables. This aligns with findings from the 2013 “STEPS” survey and a study in the Sindhuli District of Nepal, which reported similarly low consumption rates [37, 38]. The scarcity of seasonal fruits, dietary preferences, and cultural habits (e.g., prioritizing meat over fruits during ceremonies) contribute to the low intake of fruits and vegetables, highlighting the need for interventions to promote healthier dietary choices among ex-Gurkhas.

In contrast, 74% of ex-Gurkha soldiers reported engaging in the recommended levels of physical activity, which is notably higher than the 50% adherence reported among U.S. military veterans [39]. This higher prevalence of physical activity could be attributed to their past military training. However, about 25% of participants did not meet these physical activity guidelines, which may be due to the challenges of transitioning from a structured military lifestyle to civilian life. This transition often disrupts established routines, and the lack of organized exercise programs in civilian life contributes to lower physical activity levels. To address this, accessible open space public exercise parks or gym facility could play a significant role in promoting physical activity.

Our study also found that 33.9% of ex-Gurkhas were either overweight or obese, a figure comparable to U.S. veterans (38%) [40] but significantly higher than the BMI rates of the indigenous Nepali population (15.75%) [41]. The shift from a balanced, controlled military diet to a less structured civilian diet, combined with sociocultural practices that encourage overeating during social events, may contribute to this higher prevalence of overweight and obesity. In Magar community, there is a longstanding tradition of hospitality where guests are served abundant food, and it is customary to offer a little more than what is initially served. This practice, encapsulated by the phrase “*Ettar*” (meaning “a little bit more”), often leads to overeating during social gatherings, especially during festivals, weddings, and other community events.

Only 11.64% of participants reported regularly monitoring their blood glucose levels, and all of them reported to have diabetes. This highlights a significant gap in routine diabetes screening and underscores the need for improved awareness and access to diabetes testing, especially among the ex-Gurkha population. The prevalence of diabetes in our study (11.64%) is consistent with findings from other studies conducted in the urban

population of Nepal [43, 44], but is lower than the 20% prevalence observed among U.S. veterans [42].

### Predictors of hypertension

The overall prevalence of hypertension among Gurkha veterans in our study was 47.5%, which is significantly higher than the 19.5% reported in a national representative survey in Nepal [45]. Our findings were similar to those of studies conducted among military personnel in other regions, such as Dharan (34%) and Pokhara (66.2%) in Nepal [6, 7], and military personnel in China (53.1%) [46]. It is likely that early-life factors, such as maternal nutritional status during pregnancy, also contribute to cardiovascular risk [47].

Several modifiable risk factors, such as higher BMI, alcohol consumption, smoking, lack of physical activity, and poor dietary habits; are well-established contributors to hypertension [48]. Our study found a significant association between both past and current alcohol consumption and hypertension, consistent with previous research showing a link between alcohol use and elevated blood pressure [49]. This association may be due to alcohol withdrawal symptoms, which can lead to increased stress, heart rate, and fluctuations in blood pressure.

Furthermore, we observed a significant relationship between physical activity and hypertension. Participants who engaged in less than 75 minutes of vigorous exercise per week had a higher prevalence of hypertension than those who met or exceeded this threshold. This finding is consistent with studies among Indian military personnel and war veterans in Nepal, which emphasize the importance of physical activity in controlling blood pressure [6, 50].

Our study also revealed a significant association between hypertension and both BMI and waist-to-hip ratio. Hypertension was more prevalent among obese participants compared to those with normal weight, and the waist-to-hip ratio was also significantly associated with elevated blood pressure. Similar findings have been reported in studies conducted among U.S. military personnel and the general population in Nepal [51, 52].

The multivariable logistic regression analysis showed a significant positive relationship between daily alcohol drinkers, vigorous physical activity, and BMI with hypertension. Daily alcohol drinkers were 3.13 times more likely to develop hypertension than those who did not consume alcohol daily. Additionally, those who engaged in less than 75 minutes of vigorous exercise per week were 4.82 times more likely to have hypertension. Obesity significantly increased the odds of hypertension, with obese individuals nearly three times more likely to develop hypertension compared to those with a normal BMI.

Ex-Gurkhas soldiers often experience a shift from a highly active military lifestyle to a more sedentary one after retirement, accompanied by changes in diet, increased alcohol consumption, and higher BMI, all of which contribute to an elevated risk of hypertension. Additionally, limited access to healthcare services and inadequate post-service medical follow-ups further exacerbates this risk. These factors highlight the need for targeted health interventions focusing on lifestyle modifications, including weight management, regular physical activity, a healthy diet, and the regulation of other risk factors such as alcohol consumption, blood sugar, and cholesterol levels. Addressing these concerns is essential for reducing hypertension risk and improving the overall cardiovascular health of ex-Gurkhas.

### Strengths and limitations

This study has several strengths, including the use of the widely recognized and validated WHO STEPS survey questionnaire, which is specifically designed to assess risk factors for noncommunicable diseases (NCDs). By employing standardized measurement techniques during data collection, the study minimizes the risk of measurement bias and enhances the reliability of the findings. However, there are certain limitations. First, the study's cross-sectional design means it is not possible to establish causal relationships between risk factors and NCDs, as data were collected at a single time point. Second, reliance on self-reported data introduces the potential for reporting bias, where participants might provide inaccurate or incomplete information, potentially influenced by social desirability bias. Additionally, the study population, consisting only of retired Gurkhas, limits the generalizability of the findings to other populations. The unique characteristics and experiences of Gurkhas, such as their military background and cultural factors, might differ from the general population, so caution is needed when extrapolating the results.

### Conclusion

Ex-Gurkhas face a unique set of challenges following their military careers, including lifestyle changes that contribute to the risk of hypertension and other NCDs. These challenges, such as increased alcohol consumption, low physical activity, poor dietary habits, and obesity; highlight the need for targeted health interventions focused on lifestyle modification. Initiatives aimed at promoting healthy eating, regular physical activity, weight management, and the reduction of alcohol consumption can play a crucial role in improving the cardiovascular health of ex-Gurkha soldiers. Furthermore, increased access to healthcare services and regular screening for conditions such as hypertension, diabetes, and obesity are essential

to mitigating these risks and improving the overall health outcomes of this population.

### Supplementary Information

The online version contains supplementary material available at <https://doi.org/10.1186/s12889-025-22919-6>.

Supplementary Material 1.

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### Authors' contributions

NA contributed to the conceptualization, methodology, data collection, analysis, writing, review, and editing. KPS was responsible for the methodology, data analysis, results interpretation, writing, review, and editing. SP contributed to the methodology, writing, review, and editing. RA was involved in data editing, writing, review, and editing. MB participated in the methodology, data collection, writing, review, and editing. SB contributed to data editing, collection, writing, review, and editing. GD played a role in conceptualization, methodology, writing, review, and editing. SSB was involved in conceptualization, methodology, writing, and review. DB contributed to the conceptualization, methodology, data analysis, writing, and review. PKP was responsible for conceptualization, methodology, writing, review, and editing. All authors provided critical revisions to the manuscript.

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### Data availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Declarations

#### Ethics approval and consent to participate

This study adhered to the principles of the Helsinki Declaration and followed national ethical guidelines. Ethical approval was obtained from the Nepal Health Research Council (Ref. no: 2328), with written consent from the Mathagadhi rural municipality and respective ward offices. All participants provided informed consent before completing the questionnaire, ensuring confidentiality and privacy throughout the study.

#### Consent for publication

Not applicable.

#### Competing interests

The authors declare no competing interests.

#### Author details

<sup>1</sup>School of Public Health and Community Medicine, BP Koirala Institute of Health Sciences, Dharan, Nepal. <sup>2</sup>Department of Sociology and Gerontology, and Scripps Gerontology Center, Miami University, Oxford, OH, USA. <sup>3</sup>Out-patient, Inpatient and Emergency Department, Fikkal Hospital, Fikkal, Ilam, Koshi Province, Nepal. <sup>4</sup>Department of Internal Medicine, B. P. Koirala Institute of Health Sciences, Dharan, Nepal. <sup>5</sup>Department of Community Medicine,

Devdaha Medical College and Research Institute, Bhaluhi, Rupandehi, Nepal.  
<sup>6</sup>Tribhuvan University Teaching Hospital, Kathmandu, Nepal. <sup>7</sup>World Health Organization Country Office for Nepal, Kathmandu, Nepal.

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