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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

### 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



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%)

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

**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		<i>p</i> -value
		Normotensive ( <i>n</i> =99, 52.38%)	Hypertensive ( <i>n</i> =90, 47.62%)	
Socio-demographic variables				
War Involvement	Involved			

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<sup>2</sup>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,







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



35. Golden SE, Thakurta S, Slatore CG, Woo H, Sullivan DR. Military factors associated with smoking in veterans. *Mil Med.* 2018;183:E402–8. <https://doi.org/>