Indian Heart Journal 70 (2018) 598–603

Contents lists available at ScienceDirect

Indian Heart Journal

journal homepage: www.elsevier.com/locate/ihj

Original Article

Prevalence of noncommunicable disease risk factors among the Kani tribe in Thiruvananthapuram district, Kerala

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ARTICLE INFO

Article history:
Received 3 May 2017
Accepted 10 January 2018
Available online 11 January 2018

ABSTRACT

Background & objective: Noncommunicable Disease (NCD) risk factors are on the rise and often linked to the adoption of modern lifestyles. This study explores NCD risk factors in a rapidly modernising indigenous population in Kerala, the Kani tribe.
Methods: A representative sample of 298 adults of the Kani tribe in Thiruvananthapuram district was studied using the WHO stepwise framework for surveillance of NCD risk factors. Descriptive, bivariate and multivariable analysis were done using the R statistical package.
Results: Prevalence of hypertension (48.3%), use of tobacco (81.5%) and alcohol consumption (36.2%) were found to be higher in the Kani tribe compared to the general population in Kerala. Abdominal obesity (22.1%) is found to be higher in Kani tribes compared to other tribal groups in India. The physical inactivity level (9.7%) was similar to urban Kerala and higher than many other tribes in India. Hypertension was scientifically associated ($p < 0.05$) with higher age, male sex, low education levels, and tobacco intake among them. On multivariable analysis, age and alcohol consumption were found to be the prominent risk factors for hypertension and high education level was found to be a protective factor.
Conclusion: The major modifiable NCD risk factors were found to be higher among the people of the Kani tribe compared to the general population in Kerala. Physical inactivity level was comparable to urban Kerala, and obesity rates were higher than many other tribal communities in India. The findings warrants targeted action in these vulnerable communities for effective control of the noncommunicable epidemic.

1. Introduction

Noncommunicable diseases (NCDs) have surpassed communicable diseases in the global prevalence in the last decade.[1] NCDs kill more than 36 million people every year globally; 80% of these deaths occur in low and middle-income countries. Many such deaths are premature, occurring before 70 years of age and potentially preventable.[2,3]

Kinra et al[4] had demonstrated that NCD rates are steadily increasing even in the rural areas of India, and had become the leading cause of death by 2010. There is increasing evidence that marginalized groups are more at risk of NCDs as they have limited access to health services, more exposed to harmful addictions like tobacco and unhealthy diet.[2] Tribal population in India have high rates of hypertension and other risk factors of NCD.[5–8] Kerala has the highest rates of NCD risk factors in India, as reported by Thankappan et.al[9] Tribal people, that form only 1.5% of Kerala population (Census 2011) is the most disadvantaged group in Kerala.

Among the prominent tribes, the Kanikaran tribe is the most literate and 'progressive', keen to adopt modern gadgets, high-risk behaviors, unhealthy diet, etc.[10,11] This exploration of NCD risk factors among them would help to understand the mounting problem of NCD among the tribal population in Kerala.

1.1. Objective

The primary objective was to assess the prevalence of NCD risk factors among the Kani tribe in Thiruvananthapuram district, Kerala. The secondary objective was to assess determinants of hypertension in this population.

2. Materials and methods

The Kani tribe belongs to a traditional nomadic community, who now lead a primarily settled life in the forests of the

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https://doi.org/10.1016/j.ihj.2018.01.022

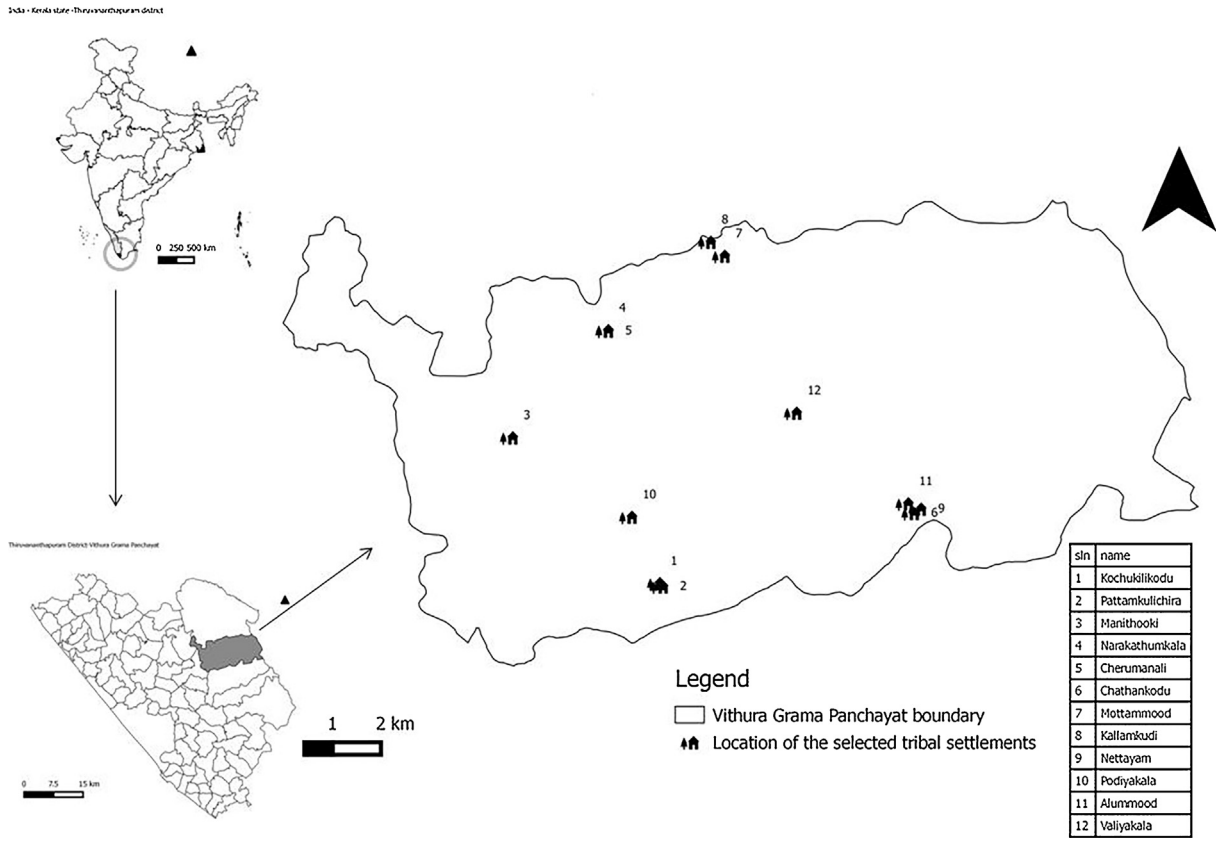

Fig. 1. Distribution of selected tribal settlements in Vithura Panchayat.

Agasthymalai hills of the Western Ghats in Thiruvananthapuram district of Kerala.[12] As per the Census 2011, 90% of the total population of 21,251 Kani tribe lives in Thiruvananthapuram district, mostly in the rural and forest areas. We have selected the Vithura Panchayath, which has the highest proportion of this tribe in Thiruvananthapuram (ITDP, 2008). Vithura Panchayath has 3908 people of Kani tribe, residing in 67 settlements and each settlement on an average has 25 households each (ITDP, 2008).

The rate of hypertension (40%) from a previous study[13] was used for sample size calculation, with the precision of 8% and a design effect of 2 and it was estimated to be 289 which was rounded up to 300, to account for potential non-response. The settlements were taken as cluster units, and from the 67 Kani settlements in Vithura Panchayath, 12 were randomly selected. The distribution of selected Kani settlements is shown in Fig. 1. One adult, in the age group of 25–64 years, each from all the households in the selected settlements were enrolled in the study. KISH table was used to select an individual from within the household and to ensure equal numbers of males and females. Data collection was done during June to October 2014.

A structured interview schedule, based on the WHO Stepwise approach for surveillance of NCD risk factors Version 3.0 was used for the study. In addition to the questions in the core and expended questionnaires of WHO Step 1 &2 sections, like tobacco use, alcohol use, fruit and vegetable consumption, physical inactivity, etc. we had incorporated more questions on demography and socioeconomic status. The interviews were done in Malayalam, and the measurements as prescribed in the WHO Step 2 (height, weight, waist circumference, blood pressure, etc.) were done by the primary author herself, who is a qualified medical nurse.

The standard operating procedures, as prescribed by WHO Stepwise strategy were strictly adhered, for taking the measurements. Blood pressure (BP) measurements were taken using OMRON digital sphygmomanometer (OMRON HEM 7203). Three readings of BP were taken and the average of the second and third reading was taken for analysis. We used TYLON non-stretchable height measuring tape (Stanley 130656) with accuracy one millimetre to measure the height, as taking stadiometer into the tribal settlements was not logistically feasible. Weight was measured using SECA 813 Electronic Flat weighing scale with an accuracy of 100 g. Waist circumference was measured using SECA constant tension tape (SECA 201) with an accuracy of one millimetre.

2.1. Ethical clearance

Ethical clearance was obtained from the Institutional Ethics Committee, Sree Chitra Tirunal Institute for Medical Sciences and Technology, Thiruvananthapuram (IEC RegnNo.ECR/189/Inst/KL/2013). Informed written consent was obtained from the participants before the start of the interview. Participation in the study was voluntary. The subject had the freedom to refuse to answer questions or opt out of the study at any stage of the research.

2.2. Statistical procedures

Data entry was done on EpiData Entry Client (version 3.2) and analysis was done using the R project -version 3.4.1(R Foundation for Statistical Computing, Vienna, Austria).[14,15] The *survey* package in R project was used to select the survey design for one stage cluster sampling to get robust estimates of confidence intervals. The Chi-square test was used for analysing the statistical significance of hypertension (the leading NCD risk factor which was used to estimate the sample size for the study) and logistic

regression was used to estimate the strengths of associations, considering a significance level at $p < 0.05$.

The adjusted odds ratios were estimated using logistic regression analysis in the *survey* package in R project. This allowed the clustering effect due to the sampling procedure to be adjusted for using robust standard errors. Age group, sex, socioeconomic status, education level, current tobacco smoking, current alcohol intake, overweight and physical activity grouping were included in the original model, which were eliminated in a backward stepwise manner using Wald test. Only three parameters, namely age group, education status and current alcohol use were retained in the final model and the Pseudo R^2 equivalent estimation by the *McFadden* statistic of the model was12.4%.

2.3. Definitions used

Tobacco use[1]: Current use of any form of tobacco was defined as consumption of smoked or smokeless form of tobacco within the past 30 days. **Alcohol use**[1]: Current use of alcohol was defined as consumption of alcohol within the past 30 days. **Fruit and vegetable consumption**[1]: It is recommended that one should eat more than or equal to five servings of fruits and vegetable per day. **Physical activity**[1]: Global Physical Activity Questionnaire (GPAQ V2) inbuilt in WHO Steps I was used to capture physical activity. The Metabolic Equivalents (MET) were calculated for groups of selected activities. The levels of physical activity were classified into three groups such as High, Medium and Low physical activity[1]. (High physical activity: >= 3000 MET-minutes/week. Medium physical activity: 600–2999 MET-minutes/week. Low physical activity/physically inactive: <600 MET-minutes/week) **Abdominal obesity**[16] was defined as waist circumference ≥90 cm for men and ≥80 cm for women. **Overweight**[1] was defined as Body Mass Index (BMI) ≥ 25 kg/m^2. **Hypertension**[1] was defined as systolic blood pressure ≥140 mm of Hg or diastolic blood pressure ≥90 mm of Hg or currently taking any medication for hypertension.

Table 1
Socio demographic profile of the Kani tribe.

VARIABLE	KANI TRIBE N = 298 (%)
Age group	
25–34 yrs	94 (31.5)
35–44 yrs	78 (26.2)
45–54 yrs	68 (22.8)
55–64 yrs	58 (19.5)
Marital Status	
Currently married	129 (43.3)
Cohabitation	104 (34.9)
Others	65 (21.8)
Education	
No formal education	39 (13.1)
Primary school	76 (25.5)
High school	149 (50.0)
Above High School level	34 (11.4)
Socioeconomic status	
Below Poverty Line	266 (89.3)
Above Poverty Line	32 (10.7)
Context specific work status of Kani tribe	
Daily wage Labour	88 (29.53)
Home makers	75 (25.17)
Mahatma Gandhi National Rural Employment Guarantee Act(MGNREGA)	43 (14.4)
Trapping milk from the rubber trees (low paid job)	22 (7.38)
Engaged in the free collection of goods (minor forest product collection)	13 (4.36)
Eera works (Traditional handicrafts)	4 (1.34)
Farmers	12 (4.0)
Regular wage employee	14 (4.7)
Others	39 (13.1)

Table 2
Prevalence of NCD risk factors among Kani tribe.

VARIABLE	PREVALENCE(N = 298)	95% CI[†]
Hypertension(JNC 7 definition)	144 (48.3%)	40.3–56.0
Overweight	32 (10.7%)	6.7–16.0
Abdominal Obesity (Asian cut off)[‡]	66 (22.1%)	14.8–30.0
Current Tobacco Use (Smoking forms)[§]	113 (37.9%)	29.7–46.0
Current Tobacco Use (Smokeless forms)	226 (75.8%)	68.1–83.0
Current Tobacco Use (Any form)	243 (81.5%)	73.2–89.0
Current Alcohol Use[¶]	108 (36.2%)	26.1–40.0
Physical Activity		
High (≥3000 METs)	230 (77.2%)	73.3–80.0
Medium(600–2999.9 METs)	39 (13.1%)	9.3–17.0
Low(<600 METs)	29 (9.7%)	5.0–16.0
Body Mass Index (BMI)		
Underweight (BMI <18.5)	50 (16.8%)	11.0–24.0
Normal (BMI 18.5–24.9)	216 (72.5%)	65.3–79.0
Overweight (BMI 25–29.9)	30 (10.1%)	7.1–14.0
Obesity (BMI ≥30)	2 (0.7%)	0.1–2.0

[†] 95% CI –95% Confidence Interval adjusted for cluster sampling design using the *survey* package in R project.
[‡] Abdominal obesity is much higher among females (38.3%).
[§] Current use of smoking form of tobacco use is much higher among males(69.1%).
[¶] Alcohol use is much higher among males(66.4%).

3. Results

Out of 311 selected study subjects contacted, 300 consented to participate in the study with a response rate of 96.4%. The non-responders were not different from the study subjects in their demographic characteristics. Two subjects were found to be outliers and were excluded from the general analysis as their anthropometric parameters (weight and height) and blood pressure were higher by more than two standard deviations from the rest. The mean age of the study participants was 42.2 years with SD 11.48. The socio-demographic profile of the study subjects is given in Table 1.

Men were mostly involved in unorganized labor works (29.5%) and rubber tree-tapping (7.4%). Women were mostly engaged in homemaking (25.17%). The prevalence of non-communicable disease risk factors (STEP 1 and STEP 2) among the Kani tribe are given in Table 2.

Prevalence of hypertension among the people of Kani tribe was 48.3%, but still, only a small proportion (7.4%) was on any form of treatment, either allopathic medicine or herbal medicine, for hypertension. Only 19.1% of the participants were aware of their hypertension status. The rate of abdominal obesity as estimated using the Asian criteria[16] was 22.1% and the rate of overweight was 10.7% (Table.2) Majority were physically active (77.2%) and the mean duration of sedentary behavior, as estimated by the time duration spent sitting or reclining on a typical day was around 5 h (4:52:11). None of the 298 people consumes five servings of fruits and vegetables per day.

The majority (81.5%) uses tobacco, either in smoking or smokeless forms. (Table.2) More men use smoking forms of tobacco (69.1%), mainly beedi, compared to women (6.7%) whereas use of non-smoking forms of tobacco was higher among women (81.9%) compared to men (69.8%). There was no significant difference between males and females in the use of smokeless forms of tobacco. It was found that 30.4% (N = 34) started their tobacco smoking habit before 18 years and 23.1% (N = 52) started their smokeless tobacco use before 18 years.

The alcohol consumption rate was 36.2%, more among men (66.4%) compared to women (6%) and they were accustomed to modern forms like brandy, rum and beer. Further detailed analysis was restricted to hypertension (Table 3).

In bivariate analysis, the risk for hypertension was found to be higher among the older age group, male sex, alcohol/tobacco users

Table 3
Association of Hypertension with demographic and behavioral parameters.

Demographic and behavioral parameters (Number of subjects)		Crude Odds Ratio (95% CI)	Adjusted Odds Ratio of final model (95% CI)
Age group	Up to mean age of 42yrs (163)	1	1
	Mean age and older (135)	4.57 (2.94–7.08)***	3.88 (2.48–6.06)***
Education	Up to High school level (115)	1	1
	Above High school level (183)	0.34 (0.36–0.45)***	0.50 (0.37–0.67)**
Current alcohol consumption	Non-users (190)	1	1
	Users (108)	1.58 (0.95–2.62)	1.91 (1.25–2.92)*
Sex	Female (149)	1	–
	Male (149)	1.72 (1.35–2.181)**	
Socioeconomic status	Below Poverty Line (266)	1	–
	Above Poverty Line (32)	0.61 (0.29–1.28)	
Current users of smoking forms of tobacco	Non-users (185)	1	–
	Users (113)	1.92 (1.29–2.88)**	
Current users of smokeless forms of tobacco	Non-users (72)	1	–
	Users (226)	1.66 (0.66–4.16)	
Overweight	Body Mass Index <25 (266)	1	–
	Body Mass Index ≥25 (32)	1.42 (0.95–2.13)	
Physical Activity Group	Low activity (29)	1	–
	Medium activity (39)	0.67 (0.25–1.82)	
	High activity (230)	0.63 (0.33–1.18)	

‡ Adjusted Odds ratio was done using logistic regression analysis in the *survey* package in R project, which is adjusted for the cluster sampling design. Age group, sex, socioeconomic status, education level, current tobacco smoking, current alcohol intake, overweight and physical activity grouping were included in the original model, which were eliminated in a backward stepwise manner using *Wald test*. The Pseudo R^2estimation by the *McFadden statistic* of the model is 12.4%.

and those who were overweight. A protective effect was found in better education and socioeconomic status. Many of these associations were statistically significant (Table 3). However, on multivariable logistic regression, the higher age group and alcohol consumption were found to be significant risk factors for hypertension and higher levels of education as a significant protective factor (Table 3).

4. Discussion

This is the first time that the WHO step-wise approach was used to estimate NCD risk factors among tribal population in Kerala. Equal numbers of men and women were enrolled in the study, and the response rate was very good (96.4%). Most of the studied Kani settlements were situated in difficult to access areas with mountains and steep terrain and often the researcher had to wait for men to return from their workplace to interview them.

Though Kani tribe is one of the most advanced and literate tribes in Kerala, only 11.4% had the education above high school level, and 13.1% has no formal education (Table 1). It seems there is an apparent shift from food crops to cash crops among the Kani tribe. Earlier they were mainly engaged in agriculture and traditional handicrafts ("Eera" works) for their livelihood. Now the proportion of farmers and "Eera" workers have come down to 4.0% and 1.3%, respectively indicating a rapid lifestyle change. Most men are daily wage laborers and often undertake rubber tapping for their livelihood.

Tobacco and alcohol consumption were found to be higher in the study subjects. Lack of health infrastructure, poor budget allocation, poor access to a health facility, shortage of qualified health workers and poverty exerted more pressure on the tribes in India to ignore their health problems.[17] The rate of current tobacco use among this tribal population was 81.5%; higher than the reported figures for the rural (24.3%), urban (22.6%) and even the slum population (37.3%) in Kerala.[9] The overall rate of tobacco smoking (37.9%) and smoking rate among men (69.1%) were higher than the corresponding rates of (22.6%) and (47.9%) in the tribal district of Kinnaur of Himachal Pradesh.[18] As in the general population, smoking was more among men than women. In a nutshell, the prevalence of tobacco smoking among this tribal group was much higher than the non-tribal population in India. The prevalence of smokeless tobacco use was 75.8%, much higher than the national average (38%)[19] and similar to the prevalence among the Mishing tribe of Assam (78.9%).[20] Among the Kani tribe, smokeless tobacco use was higher among both men (69.8%) and women (81.9%) compared to the NFHS-3 data (37% among men and 80% among women).[19] It is worth noting that among those who consume tobacco products, one third started their smoking habit and a quarter started their tobacco chewing habit much before attaining the legal age for purchase of tobacco products in India, which is 18 years.

The prevalence of current alcohol consumption among the Kani tribe was 36.2%, which is slightly higher than the national prevalence (32%).[19] Prevalence is much higher than rural, urban or slum population of Kerala and tribal districts of Kiannur of Himachal Pradesh.[9,18] Among the Kani tribes, prevalence of alcohol consumption among men and women were markedly higher than the general population of Kerala.[9] Fruits and vegetable intake among these tribes were much less when compared to the slum population in Kerala.[9] Anecdotal evidence shows that the shift from food crops to cash crops and lack of vegetable cultivation due to the scare of wild animals restrict their intake of fruits and vegetables.

A significant proportion, mainly menfolk, still indulge in strenuous physical activity compared to the general population of Kerala.[9] However the low physical activity rate of 9.7% among the study subjects was comparable to the rate of urban population of Kerala (9.5%),[9] this is higher than the rural and slum populations of Kerala[9] and that of the tribes of Assam.[20] However, it was lower compared to the sedentary habits of tribal district of Himachal Pradesh (34.5%).[18] It is heartening to see that overall physical activity was still high among the Kani tribe.

Prevalence of abdominal obesity among the Kani tribe (22.1%) is almost double when compared to Mishing tribes of Assam (11.4%)[20] and very high when compared to the tribal population of the hilly district of Himachal Pradesh (8.8%).[18] It is much less compared to urban (41.9%), rural (33.9%) and slum population (42.4%) of Kerala.[9] This may be because of high levels of physical activity among them.

The prevalence of overweight among the Kani tribe was 10.8%, which is lower than Mishing tribe from Assam[20] and tribal district of Himachal Pradesh.[18] As seen in the general population, the prevalence of abdominal obesity and overweight were higher among women compared to men in this tribal community.[21] The

higher rate of underweight (16.8%) among the Kani tribe compared to the general population in Kerala could be a reflection of their backwardness within the state.[22]

The prevalence of hypertension among the Kani tribe was much higher than the primitive tribes of Kerala (40%),[13] Assam (25.6%)[20] and Himachal Pradesh (19.7%).[18] The prevalence was closer to the urban population of Kabul City, Afghanistan (46%).[23] Prevalence of hypertension was much higher when compared to rural, urban and slum population of Kerala.[9] However, the prevalence of hypertension among the Kani tribe was less when compared to the reported figures for elderly population of Langia Saora, one of the primitive tribes of Orissa.[24]

In bivariate analysis, male sex, higher age and the habit of tobacco consumption are found to have higher odds of getting hypertension, whereas higher education and better socioeconomic status were found to be protective factors. These findings show a reversal of the social gradient for hypertension in the Kani tribe as it was found in other populations.[25–27] This is further reiterated in multivariable logistic regression analysis, which clearly lists out higher age and alcohol consumption as the prominent risk factors and higher levels of education as a protective factor. Similar findings were observed in the general population of Kerala in earlier studies.[9] Awareness, treatment and control status of hypertension was much less among the Kani tribe when compared to the general population of Kerala[9] and the tribal population of Himachal Pradesh.[18]

The Kani tribe has a rich traditional knowledge of medicinal plants; have many home remedies to manage common ailments, and herbal medicine is their preferred choice of treatment even in present times.[28–30] Unfortunately, there is no formal transfer of their traditional knowledge of medicinal herbs to the next generation now. Their levels of awareness of hypertension were deficient, despite the availability of radios and television sets in many settlements. They have many hurdles to use modern health system, due to difficulty in physical and social access, increased waiting time at the clinic, non-availability of medicines and inadequate facilities in the primary health center (PHC) and the high cost of transportation. So these people are left without their herbal medicine nor the modern medicine to manage the epidemic of NCD risk factors, mainly due to their social and economic backwardness.[31,32] There is an urgent need for the health sector to take appropriate action to safeguard their health.

This study used self-reported information on diet and physical activity and that might have resulted in an overestimation of the results. The occupational categories in the WHO questionnaire were not sufficient to capture Kani tribe's vocational activities. Also, we might have missed many contextual complexities because of the quantitative nature of the study.

5. Conclusion

The Kani tribes in Thiruvananthapuram were found to have higher prevalence of major modifiable NCD risk factors like hypertension, tobacco use, alcohol use and inadequate fruits and vegetable intake compared to the general population. Physical inactivity level was comparable to urban Kerala, and obesity rates were higher than many other tribal communities in India. This could be a reflection of the fast adoption of modern lifestyle among the Kani tribe.

Acknowledgements

We thank the Kerala State Council for Science, Technology and Environment (KSCSTE), Department of science and technology, Government of Kerala, Thiruvananthapuram, Kerala for the financial assistance granted for this study. There was no conflict of interest. The support and cooperation were obtained from the Integrated Tribal Development Project (ITDP), Nedumangad, Thiruvananthapuram. We would like to place our sincere gratitude to all the good minds that became part of this endeavour.

What is already known?

NCD risk factors are increasing nationally and globally and is often associated with the adoption of modern lifestyles. The study of NCD risk factors is important in the Kani tribes that is rapidly adopting modern lifestyles.

What does this study add?

The major modifiable NCD risk factors were found to be higher among the Kani tribe than the general population in Kerala. The risk of hypertension is found to be higher among the economically and educationally poor individuals within this marginalized group in Kerala.

References

1. GBD 2015 Risk Factors Collaborators. Global, regional, and national comparative risk assessment of 79 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990–2015: a systematic analysis for the Global Burden of Disease Study 2015. *Lancet*. 2016;388 (10053):1659–172410.1016/S0140-6736(16)31679-8.
2. Murray CJL, Vos T, Lozano R, et al. Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990–2010: a systematic analysis for the Global Burden of Disease Study 2010. *Lancet*. 2012;380(9859):2197–222310.1016/S0140-6736(12)61689-4.
3. *World Health Organization Global Status Report on Noncommunicablediseases*. WHO; 2010 http://www.who.int/nmh/publications/ncd_report2010/en/. Published 2010. (Accessed 20 February 2014).
4. Kinra S, Bowen LJ, Lyngdoh T, et al. Sociodemographic patterning of non-communicable disease risk factors in rural India: a cross sectional study. *BMJ*. 2010;341: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2946988/. (Accessed 18 February 18 2014).
5. Kerketta AS, Bulliyya G, Babu BV, Mohapatra SSS, Nayak RN. Health status of the elderly population among four primitive tribes of Orissa India: a clinico-epidemiological study. *Z Für Gerontol Geriatr*. 2009;42(1):53–5910.1007/s00391-008-0530-2.
6. Sachdev B. Prevalence of hypertension and associated risk factors among Nomad Tribe groups. *Online J Anthropol*. 2011;7:181–189.
7. Mukhopadhyay B, Mukhopadhyay S, Majumder PP. Blood pressure profile of Lepchas of the Sikkim Himalayas: epidemiological study. *Hum Biol*. 1996;68 (1):131–145.
8. Basavegowda M, Ashok N, Hathur B. Hypertension An emerging threat among tribal population of Mysore; Jenu Kuruba tribe diabetes and hypertension study. *Int J Health Allied Sci*. 2013;2(4):27010.4103/2278-344X.126748.
9. Thankappan KR, Shah B, Mathur P, et al. Risk factor profile for chronic non-communicable diseases: results of a community-based study in Kerala, India. *Indian J Med Res*. 2010;131:53–63.
10. Kakkoth Seetha. The primitive tribal groups of Kerala: a situational appraisal. *Stud Tribes Tribals*. 2005;3(1):47–55.
11. Nithya NR. Globalization and the Plight of Tribals: the case of Kerala. *Dawn J*. 2014;3(1):727–758.
12. Anuradha RV. Sharing with the Kanis: a case study from Kerala, India. *Submitted to the Secretariat of the Convention on Biological Diversity*. https://www.cbd.int/financial/bensharing/india-kanis.pdf (Accessed 19 February 2014).
13. Meshram I, Arlappa N, Balkrishna N, Rao K, Laxmaiah A, Brahmam GNV. *Prevalence of Hypertension, Its Correlates and Awareness Among Adult Tribal Population of Kerala State, India*. 2012;58:http://www.jpgmonline.com/article.asp?issn=0022-3859;year=2012;volume=58;issue=4;spage=255;epage=261;aulast=Meshram.
14. R Development Core Team. *R: A Language and Environment for Statistical Computing*. Vienna, Austraia: R Foundation for Statistical Computing; 2008http://www.R-project.org.
15. Chongsuvivatwong V. *Analysis of Epidemiological Data Using R and Epicalc. Epidemiology Unit*. Prince of Songkla University; 2008 http://r4d.dfid.gov.uk/Output/185689/Default.aspx. (Accessed 4 January 2015).
16. *Mangolian STEPS Survey on the Prevalence of Non Communicable Disease and Injury Risk Factors-2009*. Geneva: WHO; 2010.
17. Mavalankar D. Doctors for tribal areas: issues and solutions. *Indian J Community Med*. 2016;41:172–176.

18. Negi 18, Rana R, Vidyasagar V, Lal K. Epidemiological study of non-communicable diseases (NCD) risk factors in tribal district of Kinnaur, HP: a cross-sectional study. *Indian Heart J*. 2016;68(5):655–66210.1016/j.ihj.2016.03.002.
19. International Institute for Population Sciences. *National Family Health Survey (NFHS-3), 2005–06: India*. Mumbai, India: International Institute for Population Sciences; 2007.
20. Misra PJ, Mini GK, Thankappan KR. Risk factor profile for non-communicable diseases among Mishing tribes in Assam, India: results from a WHO STEPs survey. *Indian J Med Res*. 2014;140(3):370.
21. Sugathan TN, Soman CR, Sankaranarayanan K. Behavioural risk factors for non communicable diseases among adults in Kerala, India. *Indian J Med Res*. 2008;127(6):555–563.
22. National Institute of Medical Statistics. *Indian Council of Medical Research (ICMR). IDSP Non-Communicable Disease Risk Factors Survey, Phase-I States of India, 2007–08*. New Delhi, India: National Institute of Medical Statistics and Division of Non-Communicable Diseases, Indian Council of Medical Research; 2017.
23. Saeed KMI. Prevalence of risk factors for non-communicable diseases in the adult population of urban areas in kabul city, Afghanistan. *Cent Asian J Glob Health*. 2014;2(2)10.5195/cajgh.2013.69.
24. Kerketta AS, Bulliyya G, Babu BV, Mohapatra SSS, Nayak RN. Health status of the elderly population among four primitive tribes of Orissa India: a clinico-epidemiological study. *Z Für Gerontol Geriatr*. 2009;42(1):53–5910.1007/s00391-008-0530-2.
25. Reddy KS, Prabhakaran D, Jeemon P, et al. Educational status and cardiovascular risk profile in Indians. *Proc Natl Acad Sci U S A*. 2007;104(41):16263–16268.
26. Jeemon P, Reddy KS. Social determinants of cardiovascular disease outcomes in Indians. *Indian J Med Res*. 2010;132:617–622.
27. Prabhakaran D, Jeemon P, Reddy KS. Commentary Poverty and cardiovascular disease in India: do we need more evidence for action? *Int J Epidemiol*. 2013;42(5):1431–1435.
28. Ayyanar M, Ignacimuthu S. Traditional knowledge of kani tribals in kouthalai of Tirunelveli hills, Tamil Nadu, India. *J Ethnopharmacol*. 2005;102(2):246–255.
29. Ayyanar M, Ignacimuthu S. Ethnobotanical survey of medicinal plants commonly used by Kani tribals in Tirunelveli hills of Western Ghats, India. *J Ethnopharmacol*. 2011;134(3):851–864.
30. Ayyanar M, Sankarasivaraman K, Ignacimuthu S. Traditional herbal medicines used for the treatment of diabetes among two major tribal groups in South Tamil Nadu, India. *Ethnobot Leafl*. 2008;2008(1):32.
31. Seetha Kakkoth. The primitive tribal groups of Kerala: a situational appraisal. *Stud Tribes Tribals*. 2005;3(1):47–55.
32. Nithya NR. Globalization and the plight of tribals: the case of kerala. *Dawn J*. 2014;3(1):727–758.