Original Article

Role of Chronobiology in Determining the Distribution of Non-Communicable Diseases across Geographies-Thinking beyond Diet

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Abstract

Background: Over the last few years, it is being realised that the increasing burden of non-communicable diseases (NCDs) may be linked to some macro-level determinants. **Material and Methods:** The present systematic review uses data distributed across geographies to explore the role played by chronobiology. **Results:** The paper is based on the role of these factors in affecting the prevalence of diabetes, hypertension and dementia. The paper uses extensive empirical scrutiny, covering areas across a state and applying the outcome of these to generate a hypothesis. **Conclusion:** Our results though initial indicate that change in chronotype appears to contribute to an increase in NCDs.

Keywords: Chronotype, diet, non-communicable diseases, North India

Introduction

Evidence on the burden of non-communicable diseases (NCDs) and its risk factors is not only available in high-income countries but also in low- and middle-income countries (LMICs).[1-4] As per the WHO estimates NCDs were responsible for 68% of the world's deaths in 2012, with >40% of those considered as "premature occurring before the age of 70. The WHO says that three-quarters of all NCD deaths and the clear majority (82%) of premature deaths occur in LMICs.[5] The data, therefore, point to a clear-cut differential distribution of NCDs worldwide. The distribution has also been seen to differ across geographies within specific nations.

One of the key determinants of this expanding burden of NCDs is the difference in the major- and macro-level drivers across geographies.[6]

It has been observed urbanisation leads to the nutritional transition towards diets high in saturated fats, sugar and calories, thereby contributing to the spread of obesity, diabetes and high-blood pressure (BP). The urban economy may also lead to a reduction in energy expenditure because of the structural economic transition from agriculture to less physically demanding service employment.[7]

An interesting study by Pruimboom *et al*. in 2017 reported that healthy adults after following a 10-day hunter-gatherer lifestyle improvement in body mass, glucose homeostasis and circulating lipids.[8] This suggests that living a traditional lifestyle may reduce the risk of developing NCDs such as diabetes mellitus (DM), hypertension (HTN) and neurodegenerative disorders. However does urbanisation influence NCDs by its role in influencing diet of individuals only? Or is there something beyond diet?

In this paper review findings from published studies conducted across different geographical locations across the same state to explore the possible role played by chronobiology in determining the distribution of NCDs.

Materials and Methods

Data sources and searches

A systematic search was conducted using Medline, Embase and the Cumulative Index to Nursing and Allied Health

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Literature (CINAHL) electronic databases to identify studies related to NCDs. The search strategy was reviewed, and the test run was conducted by content experts (SKR, AM). The literature review process followed the preferred reporting items for systematic reviews and meta-analyses. As NCDs with higher prevalence and a heavier burden on the health system, the emphasis was treated with HTN, diabetes and dementia.

We used combinations of medical subject headings and free text words that included search terms related to the exposure (e.g., prevalence, NCDs, HTN, raised BP, high BP, diabetes, high blood sugar, DM, dementia, Himachal Pradesh and state), which were combined with search terms related to the outcomes (dietary habits, urban, rural and tribal). The filters included were English for the language category and humans for the study category. We identified articles eligible for further review by performing an initial screen of identified titles or abstracts, followed by a full-text review.

Study selection

Reference lists and citations were used to cross-check the results of our search. As detailed above, studies were selected after using free text words prevalence, NCDs, HTN, raised BP, high BP, diabetes, high blood sugar, DM, Dementia, Himachal Pradesh, state on Medline, Embase and the CINAHL electronic databases using standard search procedure. The search yielded a total of 18 studies. The reference details and abstracts of these 18 articles were narrowed down to 12 articles after duplicates were removed through a thorough review by one of the authors who reviewed all the studies (MK). We did not restrict by type of the study design. The search was limited to English.

Data extraction and quality assessment

Each paper was reviewed, and information was extracted based on the following characteristics:

1. Study location
2. Condition – the NCD which was assessed by the paper
3. Sample size
4. Settings – a classification based on whether the study was conducted in a hospital or population setting.

Data synthesis and analysis

Due to the anticipated heterogeneity of included studies, no plans were made to pool the results statistically; therefore, a meta-analysis was not undertaken.

Results

There were 12 full-text articles, 7 which focussed on the prevalence of HTN, 2 which focussed on the prevalence of HTN and diabetes (both), one focussed on DM only and three focussed on dementia only [Tables 1 and 2].

A study on the prevalence of HTN in the tribal area of Himachal Pradesh in 1982 arrived at a rate of 1.9%. The prevalence of HTN has been reported as 19.6% and DM as 6.9% among the tribal population of Kinnaur, Himachal Pradesh in North India.[16] Raina *et al*. estimated the prevalence of HTN in a tribal landlocked population at high altitude in 2016. The study population belonged to an ethnically homogenous population of natives of Pangi valley residing at an altitude of 3048–3658 m in Himachal Pradesh, North India. The prevalence of HTN in this population was at 10.7%, which is much lower than the prevalence reported (36%) for mainland Himachal Pradesh.[20]

A higher overall prevalence of HTN was found in rural areas of Himachal Pradesh.[11] Kapoor *et al*. in 2014 found that the urban tribes had a significantly higher prevalence of central obesity, Stage I and Staged II HTN and DM than rural tribes.[14] Raina *et al*. in 2014 observed that dementia is rare in the tribal elderly population above 60 years of age in the Himalayan region of North India. Dementia is much more common in urban (with the least number of elderly above 80 years of age) and migrant population in comparison to rural population.[19]

Discussion

Findings from studies including the present one suggest that urbanisation may be a strong predictor of NCDs. However how exactly does urbanisation influence NCD? It is important to understand the probable mechanisms at play in this relation. Some of the most worked up theories in this relation are based on the relation between diet and urbanisation. According to this, the potentially helpful effects of urbanisation on NCD risk factors (through, e.g., availability of preventive health services) may be outweighed possibly by less healthful diets. Add to this is the lack of exercise and higher stress levels in the urban population. Studies have shown that people living in cities may tend to get more exposed to energy-dense foods and may develop a greater preference for calorie-rich 'Western' diets or may have reduced opportunities for physical activity.[7,21-25] Going by this argument, all urban populations should have an appreciably higher prevalence of NCDs in comparison to rural and tribal population.

However, our report points to the contrary. All NCDs except Dementia are showing a uniformly higher prevalence across geographies with urban areas showing a higher prevalence than rural and tribal populations. It was postulated that two variables related to energy intake, total calorie and fat per capita supply, are potentially mediating the association between urbanisation and NCD risk factors. This finding seems, particularly salient given the strong evidence that overweight burden is significantly driven by growing calorie consumption from energy-dense foods.[26-28]

Importantly, however, it is being noted that the association between urbanisation and three NCDs risk factors is always positive but considerably stronger in the sample of LMICs as compared to the high-income countries (HICs). According to Goryakin and Suhrcke and Popkin *et al*., living in urban areas is positively associated with the probability of being overweight predominantly in the low-income countries.[22,29] It is being suggested that this difference between LMIC and HIC countries may be due to a trade-off between the demand for

Table 1: Details of the studies reviewed for prevalence of hypertension

Article	Authors	Year	Prevalence (%)	Sample	Population
			HTN		
Blood pressure in a community at high altitude (3000m) at Pooh (north India)[9]	Dasgupta *et al*.	1982	1.9	982 (15-74 years age)	Tribal
Prevalence and awareness of HTN in a closed community of north India[10]	Gupta *et al*.	1998	33.2	7630 employees (20-60 years)	Urban
Prevalence, awareness and control of HTN in rural communities in HP[11]	Bhardwaj *et al*.	2010	Kunihar: 42.4 Haripudhar + sahu: 18.08	1092 adults age 18 years and above	Rural
Epidemiological study of HTN in natives of spiti valley in Himalyas and impact of hypobaric hypoxemia[12]	Negi *et al*.	2012	22.5	413 adults, age 20 years and above	Tribal
Morbidity pattern and health seeking behaviour of aged population residing in Shimla Hills of north India[13]	Sharma *et al*.	2013	25 56	400 elderly aged 60 years	Rural Urban
Prevalence of DM and its risk factors among permanently settled tribal individuals in tribal and urban areas in northern state of sub himalyan region[14]	Kapoor *et al*.	2014	HTN stage: 1-22.8 HTN stage: 2-5.3 HTN stage: 1-10.2 HTN stage: 2-0.9	8000 adults (tribal: 4000; urban: 4000)	Urban Tribal
Risk factor profile for non-communicable diseases in public institutions of Shimla, Himachal Pradesh, India[15]	Sandhu *et al*.	2016	32.6	350 (15-70 years age)	Urban
Epidemiological study of NCD risk factor in tribal district of Kinnaur[16]	Negi *et al*.	2016	19.7	3582 (20-70 years of age)	Tribal
Prevalence of HTN in tribal land locked population at high altitude[17]	Raina *et al*.	2016	10.7	401 aged above 20 years	Tribal

HTN: Hypertension, DM: Diabetes mellitus, NCD: Noncommunicable diseases

Table 2: Details of the studies reviewed for the prevalence of diabetes and dementia

Article	Authors	Year	Prevalence (%)	Sample	Population
			Diabetes mellitus		
Morbidity pattern and health-seeking behaviour of the aged population residing in Shimla Hills of North India[13]	Sharma *et al*.	2013	2 9.5	400 elderly aged 60 years	Rural Urban
Prevalence of DM and its risk factors among permanently settled tribal individuals in tribal and urban areas in the northern state of sub himalyan region[14]	Kapoor *et al*.	2014	DM fasting: 7.8 DM OGTT: 8.5 DM fasting: 3.9 DM OGTT: 4.1	8000 adults (tribal: 4000; urban: 4000)	Urban Tribal
Epidemiological study of NCD risk factor in the tribal district of Kinnaur[16]	Negi *et al*.	2016	6.9	3582 (20-70 years of age)	Tribal
			Dementia		
Prevalence of cognitive impairment and related factors among the elderly: A population-based study[18]	Sharma *et al*.	2013	1.3 2.3	200 urban and 200 in rural above 60 years of age	Urban Rural
Is dementia differentially distributed? A study on the prevalence of dementia in migrant, urban, rural and tribal elderly population of himalyan region[19]	Raina *et al*.	2014	0 3.2 1.4 1.8	2000 above 60 years of age	Tribal Urban Rural Migrant
Dementia in a tribal landlocked elderly population at high altitude[17]	Raina *et al*.	2016	1.2 (MCI) 0 (dementia)	481 above 60 years of age	Tribal

HTN: Hypertension, DM: Diabetes mellitus, NCD: Non-communicable diseases, MCI: Mild cognitive impairment

calories and the demand for healthy lifestyles whose balance depends on the level of country income. Accordingly, in the LMICs, living in urban areas is associated with greater demand for calories compared to rural areas, and as countries get richer, the demand for thinness and for healthier lifestyles increases, especially among the urban residents.[30] The theory although critically sound appears contradictory.

Himachal Pradesh with 90% of its population living in rural areas is still predominantly rural society. This predominantly rural society is showing a differential distribution between Urban: Rural, Urban: Tribal, Rural: Tribal and importantly one tribal against another tribal region. No doubt socioeconomy is planning a part. There exist wide disparities in the socioeconomic status across populations in Himachal Pradesh, and tribal Himachal is no exception to this. With the change in socioeconomy and increase in accessibility Kinnaur and Lahaul-Spiti has become more urbanised as compared to Pangi and Bharmour in Chamba district.

However, this urbanisation has not translated into obesity being the sole carrier of NCD risk in Himachal Pradesh as most of the people with diabetes are either normal weight or overweight but not obese in our part of India.[31] The urbanisation (howsoever) little has occurred in Himachal Pradesh has not been able to influence NCDs through its impact on obesity, thereby pointing to some other factor playing a role. Himachal Pradesh like the rest of India has seen a movement away from a predominantly agricultural society due to increasing urbanisation in the past few decades. The impact of this urbanisation is most obviously being observed in our socialisation. Being a predominantly agriculture economy with limited technological advancement, Indians have predominantly been early risers. The rural and the tribal areas of India continued to live in this 'early morning risers social set up' for the longest time in its evolutionary history. This 'early morning risers social set up' therefore has been defining chronotype of Indians in general as most of India continues to be rural in its economy. Chronotype refers to the time of the sleep and regular activities of an animal in sleep research and sleep science. As applied to humans, chronotype refers to an individual's regular rising and bedtimes. Chronotype also reflects the level of activity and vigilance during waking periods, body temperature, BP and serum cortisol Levels. People are usually divided into morning types and evening types.

Chronotypes are affected by genetic predisposition and age of individuals and shift is a marker of adulthood. India is and continues to be a socially morning chronotype. However, a shift in the economy has necessitated a change in this socialisation. This change has led to a social jet lag. Because of this social jet lag is chronic and persistent it is adversely affecting body temperature, BP and serum cortisol thereby leading to an increased risk for NCDs. In contrast, our tribal population continues to follow the morning chronotype-being largely agriculture or agropastoral with ancient mild stress factors-probably protection against NCDs such as DM and HTN.

Conclusion

Results though initial indicate that change in chronotype appears to contribute to an increase in NCDs.

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Conflicts of interest

There are no conflicts of interest.

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