BAOJ Cancer Research & Therapy

Aleyamma Mathew, et al, BAOJ Cancer Res Ther 2017, 2: 2
2: 029

Research

Urban-Rural Gradients in Cancer Incidence and Mortality among Males in Trivandrum, Kerala

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Abstract

Background

Urban-rural disparities of cancer incidence and mortality have been observed among males around the world. This study assessed disparities of cancer incidence and mortality among males in urban and rural populations of Trivandrum, South India.

Methods

Crude (CR) and age-standardized (ASR) incidence and mortality rates and rate ratios (RR) along with 95% confidence interval (CI) were calculated using Trivandrum population-based cancer registry data for 2012-2014.

Results

Crude incidence rates (per 10^5) were 181 in urban and 149 in rural (ASR: 149 in urban & 122 in rural) with 21% higher incidence (CI:1.2-1.3) and 7% mortality (CI:=1.0-1.16) and lower fatality (mortality/incidence) (38.3% urban vs. 43.0% rural) in urban. Common cancers were lung (CR: 19.2, ASR: 15.4), prostate (CR: 19.0, ASR: 15.0) and colo-rectum (CR: 15.3, ASR: 12.4) in urban and lung (CR: 21.7, ASR: 17.5), colo-rectum (CR: 11.3, ASR: 9.2) and mouth (CR: 8.5, ASR: 6.8) in rural. Higher incidence of 135% were observed for prostate (95% CI: 2.0-2.8), 70% kidney (CI: 1.3-2.3), 59% urinary bladder (CI: 1.3-2.0) and 36% colo-rectum (CI: 1.2-1.6) and lower incidence (12%) of lung cancer (RR: 0.88, CI:0.8-1.0) in urban.

Conclusion

A distinction is drawn in cancer incidence and mortality between urban and rural population in Trivandrum. Higher incidence of prostate, colo-rectal and genito-urinary cancers might be due to some changes in life-style factors, more similar to "western" jurisdictions and due to improved health care access in urban population.

Key words: Cancer Incidence; Cancer Mortality; Urban-Rural Differences

Introduction

Globalization and the increased opportunities in health care access have led greatly to a lifestyle homogenization and thereby similar disease pattern worldwide. However, differential patterns of cancer incidence and mortality have been observed between urban and rural communities around the world [1]. The differences in cancer incidence mainly depend on the exposure difference in the risk factors and the differences in the access in diagnostic and therapeutic services. Measurement of cancer disparities between urban and rural residents is a fundamental aspect of cancer surveillance. In low and middle income countries, rural residents may have less access to advances in medical technologies and improved access to healthcare, and travel barriers may be greater. Some studies have reported that social, cultural, economic, occupational, environmental and demographic factors are the major driving forces behind the urban-rural disparities in cancer incidence and mortality [2,3].

Within Asia, large differences in rates are found between urban and rural population. Based on all available data from South Asia, incidence rates of cancers such as esophagus, stomach and mouth cancers are lower in urban than rural population. In contrast to this, certain cancers such as prostate, colon and rectum, incidence rates are higher in urban [4]. The figures indicate that the transition from a rural to an urban society within South Asia is associated with large increases in cancer risk. The cause of this urban-rural difference is not known although it is likely to be due to one or more lifestyle factors such as smoking, dietary habits, socioeconomic status and other exposures which differ between urban and rural population.

It is recognized that within Kerala in South India, cancer is a growing threat to public health. Urban-rural difference according to education among men in Kerala is minimal (literacy rate: 86.8% in urban and 84.3% in rural) and the distances by road between the main oncology centers in urban Trivandrum and the rest of the regions are small and it is therefore possible to hypothesis

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Sub Date: December 6, 2016, **Acc Date:** December 18, 2016, **Pub Date:** January 2, 2017.

Citation: Aleyamma Mathew, Preethi Sara George, Jagathnath krishna KM, Kalavathy MC and Paul Sebastian (2017) Urban-Rural Gradients in Cancer Incidence and Mortality among Males in Trivandrum, Kerala. BAOJ Cancer Res Ther 2: 029.

that urban-rural differences in access to these public services is minimal. However, the magnitude and pattern of cancer incidence and mortality may differ by type of residence due to the difference in socio-demographic and life-style factors.

The purpose of this analysis was to describe urban-rural gradients of male cancer incidence and mortality and to assess inequalities in the quality indicators of data (indirectly to measure access in public services) by making use of Population Based Cancer Registry (PBCR), Trivandrum district data for the year 2012-2014.

Materials and Methods

PBCR, Trivandrum district covers an area of 2,192 sq.kms and a male population of 15,81,678 (Census of India, 2011). People residing for a minimum period of 1 year in Trivandrum district are considered as residents. Urban-rural classification has been made according to Taluk-wise. The registry area includes four Taluks. Trivandrum Taluk is considered as 'urban' as 92% population is urban. The rest of the three Taluks in the district is considered as 'rural' as the type of residence is rural in 67% of this population. Two government [Regional Cancer Centre (RCC), the physical location of the registry and Medical College Hospital] and a private hospital are the major oncology (radiotherapy treatment services) centres in Trivandrum. In addition, a large number of private and government hospitals also diagnose and treat cancer patients. Cancer registration in India is carried out by active case finding method. Based on an administrative letter provided by the Government of Kerala, south India, to all health authorities in the district in 2011, co-operation from all hospitals has been obtained. The registry employs 14 tumor registrars who were trained in cancer registration, scrutinizes medical records and other departments concerned with cancer diagnosis of about 60 potential data sources and 7 pathology laboratories at regular intervals to abstract data on incident cancer cases. Information collected includes age, residential address, gender, religion, marital status, education, mother tongue, date of incidence, basis of diagnosis, topography, morphology, clinical extent of disease, treatment details and vital status. Address linkage of cancer patient data, obtained from pathology laboratories, are made. Cases registered include all invasive cancers (ICD-10:C00 to C50; C60-C96).

Mortality data obtained from the vital statistics department includes Trivandrum Corporation, 76 panchayats and 4 municipalities in the registry area. Almost all these offices are computerized. In Kerala, almost all deaths are registered, but cause of death is not accurate. Hence all-cause mortality data were obtained from all the above sources. Using all-cause mortality, cancer deaths were obtained by making special effort of matching it with the cancer incidence data. Firstly, all cancer deaths were compared with the 'cancer incidence database'. Any death, which was matched with the incidence database, the corresponding site of cancer was added to the 'cancer mortality database'. Secondly, any cancer death, but unmatched with incidence database, were included in both incidence (Death Certificate Only: 'DCO') and mortality database after verification through house visits. Thirdly, 'non-cancer specific-mortality database (excluded deaths due to accidents or natural calamity)' was matched with the 'cancer incidence database'. If all details except cause of death were matched with this incidence database, such deaths were also added to the 'cancer mortality database' and their cause of death was recorded as the respective cancer site. Data entry, consisting checking (comparing the values of certain variables against the others), and duplicate eliminations (also manually) were carried out using a customized version of the PBCR DM 2.1software.

Statistical methods

Using the census of India (2011) data and growth rate from 2001 to 2011, the Taluk-wise population of the district for the years 2012-2014 were estimated using distribution difference method [5]. Quality indicators by type of residence were assessed in terms of proportion of microscopic verification, 'DCO' and ill-defined sites. The results were presented as the number of cases by site (ICD-10) and type of residence, with crude incidence (CR) and mortality (CMR) rates, age-specific incidence (ASpR) rates, age-standardized (direct method using the world standard population) incidence (ASR) and mortality (ASMR) rates per 10^5 males. Rate ratio (RR) along with 95% confidence interval (CI) and Chi-square p-value by assuming approximate normal distribution were also estimated. Fatality ratio (mortality/incidence) was assessed for each cancer site by type of residence [6].

Results

A total of 7613 male cancer patients were diagnosed during 2012-2014 from Trivandrum (3026 urban and 4587 rural). Microscopic diagnosis (MD) was 84% and 80%, 'DCO' was 8.0% and 9.4% and 'ill-defined sites' were 1.3% and 2.0% in urban and rural respectively. Microscopic diagnosis was more than 85% for most of the cancer sites except for lung, liver and pancreas in both urban and rural populations and no major difference in MD was observed by type of cancer (Table 1).

Cancer incidence (CR) rates (per 10^5) were 181 in urban and 149 in rural (ASR:149 in urban and 122 in rural) and showed significantly higher (21%) incidence rates (CI: 1.2-1.3) in urban. The common cancers (rate per 10^5) in urban were lung (CR: 19.2, ASR: 15.4), prostate (CR: 18.6, ASR: 14.9), colo-rectum (CR: 15.3, ASR: 12.4), lymphoma (CR: 9.3, ASR: 7.8) and tongue (CR: 9.0, ASR: 7.3) and these cancers together accounted 40% of all male cancers in urban. The common cancers in rural were lung (CR: 21.7, ASR: 17.5), colo-rectum (CR: 11.3, ASR: 9.2), mouth (CR: 8.5, ASR: 6.8), prostate (CR: 7.8, ASR: 6.4) and lymphoma (CR: 7.1, ASR: 5.9) and these cancers accounts 38% of all male cancers in rural (Table 1).

Significantly higher rate ratios in urban was observed for prostate (RR: 2.35; CI: 2.0-2.8), kidney (RR: 1.7; CI: 1.3-2.3), urinary bladder (RR: 1.59; CI: 1.3-2.0), colo-rectal (RR: 1.36; CI: 1.2-1.6), lymphoma (RR: 1.33; CI: 1.1-1.6) and multiple myeloma (RR: 1.6; CI: 1.2-2.1). Cancers such as stomach, liver, thyroid, brain & other central nervous system of tumors (CNS) had also significantly higher incidence rates in urban. Higher rates, but non-significant in urban were observed for tongue and larynx cancers, but lung cancer (RR: 0.88) had higher incidence rates in rural with borderline significance. Other tobacco-related cancers such as mouth and esophageal cancers had also higher rates in rural, but

non-significant (Table 1). Age-specific incidence rate of common cancers such as oral cavity, pharynx, esophagus, lung and liver was almost similar between urban and rural populations. The rates of prostate and colo-rectal cancers in 65+ age-group were higher in urban population, but not statistically significant (Figure 1).

Mortality (CMR) rates (per 10^5) were 69.4 in urban and 64.0 in rural (ASR: 56.2 in urban and 52.3 in rural) with a borderline significance (RR: 1.07; CI: 1.0-1.16). Prostate cancer (RR : 1.66; CI: 1.12-2.44) had a significantly higher mortality rates in urban. Significantly higher mortality in urban was observed for stomach (RR: 1.36; CI: 0.97-1.92), liver (RR: 1.38; CI: 0.97-1.96), lymphoma (RR: 1.59; CI: 1.03-2.45) and leukemia (RR: 1.33; CI: 0.91-1.94). Fatality ratio was slightly higher in rural (38.3% in urban vs. 43% in rural). Significantly higher fatality ratio was observed in rural for specific cancer sites such as pharynx (42.1% urban vs. 51.6% rural), colo-rectum (21.1% urban vs. 28.2% rural), larynx (27.8% urban

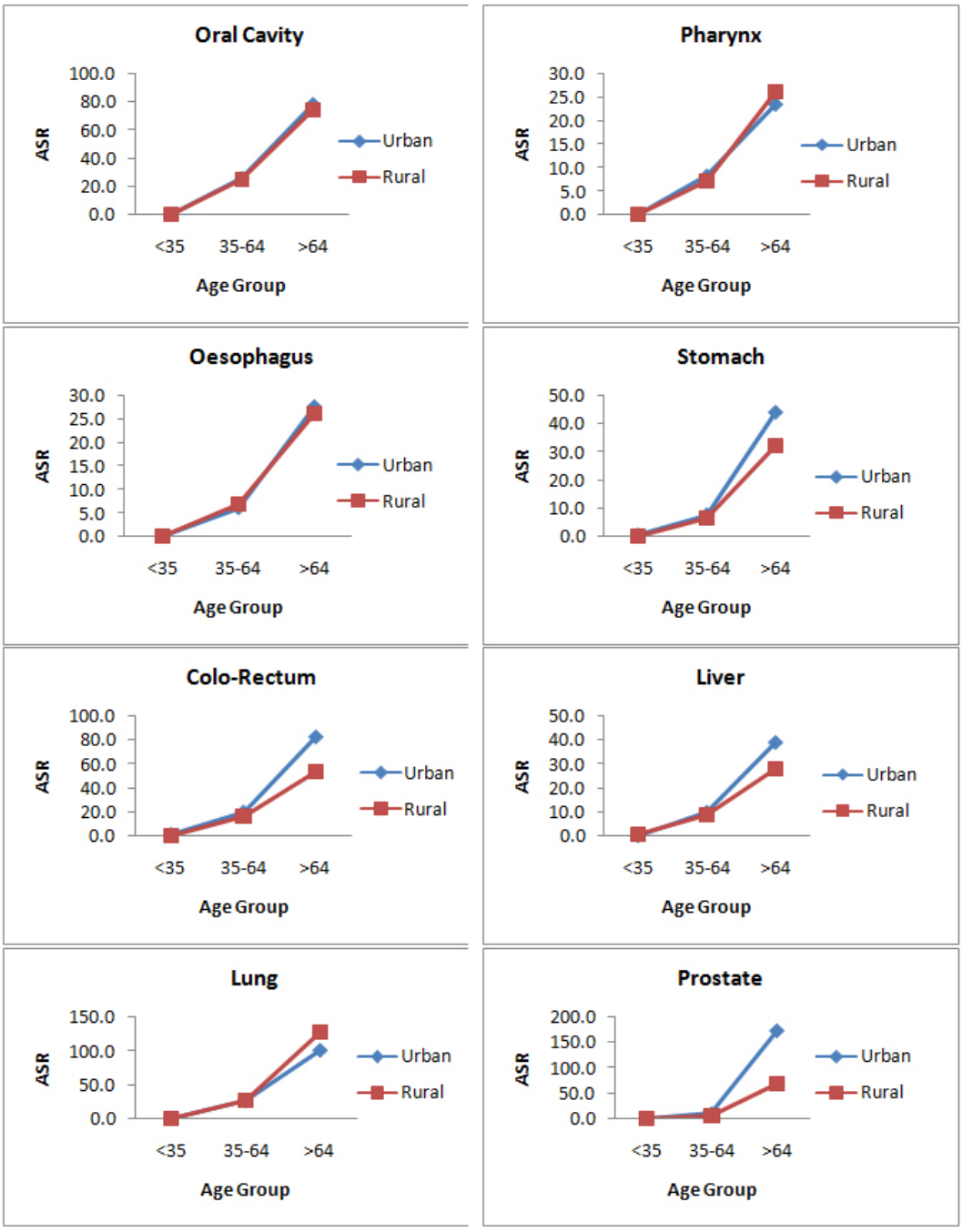

Figure 1: Urban- Rural comparison of Male Cancer Incidence in Trivandrum (2012-2014)

Table 1. Urban-Rural comparison of Male Cancer Incidence in Trivandrum (2012-2014)

	Number	MD (%)	CR			ASR		RR (CI)	P
Site	U/ R	U/R	U	R	Diff.	U	R		
All sites	3026/4587	86.0/82.4	181.3	148.7	32.6	148.6	122.3	1.21(1.2-1.3)	0.001*
Oral cavity (lip, mouth & tongue) & pharynx									
Oral cavity	287 / 511	96.2/93.2	17.2	16.6	0.6	13.8	13.3	1.04(0.9-1.2)	0.621
Tongue	150/236	98.0/95.3	9.0	7.7	1.3	7.3	6.1	1.20(0.9-1.5)	0.125
Mouth	129/261	94.6/90.8	7.7	8.5	-0.8	6.2	6.8	0.91(0.7-1.2)	0.396
Pharynx	88 / 157	87.5/91.1	5.3	5.1	0.2	4.2	4.1	1.02(0.8-1.3)	0.796
Digestive organs									
Esophagus	79 / 150	88.6/91.3	4.7	4.9	-0.2	3.7	3.9	0.96(0.7- 1.3)	0.841
Stomach	119 / 171	87.4/89.5	7.1	5.5	1.6	5.6	4.5	1.26(1.0- 1.6)	0.035
Colo-rectum	256 / 348	93.8/91.7	15.3	11.3	4.0	12.4	9.2	1.36(1.2- 1.6)	0.001*
Liver	124 / 182	67.0/57.0	7.4	5.9	1.5	6.0	4.8	1.25(1.0- 1.6)	0.048*
Pancreas	56 / 102	80.4/67.0	3.4	3.3	0.1	2.6	2.6	0.9(0.7 - 1.4)	0.934
Respiratory organs									
Larynx	126 / 192	88.9/88.0	7.6	6.2	1.4	6.2	5.0	1.23(1.0-1.5)	0.09**
Lung	320 / 669	81.6/81.5	19.2	21.7	-2.5	15.4	17.5	0.88(0.8-1.0)	0.07**
Genital & urinary tract organs									
Prostate	310 / 239	96.1/93.2	18.6	7.8	10.8	14.9	6.4	2.35(2.0-2.8)	0.001*
Kidney	80 / 87	93.8/90.0	4.8	2.8	2.0	3.9	2.3	1.70(1.3-2.3)	0.001*
Bladder	133 / 155	95.5/93.5	8.0	5.0	3.0	6.5	4.1	1.59(1.3-2.0)	0.001*
Brain, other central nervous system (CNS) & Thyroid									
Brain, CNS	66 / 88	88.0/89.0	4.0	2.9	1.1	3.6	2.5	1.45(1.1-2.0)	0.045*
Thyroid	87 / 116	98.0/100	5.2	3.8	1.4	4.5	3.3	1.36(1.0-1.8)	0.021
Hematological malignancies									
Lymphoma	155 / 219	100/100	9.3	7.1	2.2	7.8	5.9	1.33 (1.1-1.6)	0.011*
Myeloma	92 / 106	100/98.1	5.5	3.4	2.1	4.5	2.8	1.60 (1.2-2.1)	0.001*
Leukaemia	100 / 174	100/100	6.0	5.6	0.4	5.8	5.6	1.04 (0.8-1.3)	0.635

MD: Microscopic diagnosis, RR: Rate ratio urban vs. rural, CI:95% confidence interval, *significant at 5% level, ** borderline significance; CR: crude; ASR: Age-standardised rates

vs. 32.3% rural), prostate (15.5% urban vs. 22.6% rural), urinary bladder (12.8% urban vs. 21.3% rural), brain (30.3% urban vs. 39.8% rural) and multiple myeloma (28.3% urban vs. 37.7% rural) (Table 2).

Discussion

In the present analysis, we observed a higher cancer incidence (21%) and mortality (7%) in urban males compared to rural population in Trivandrum. Some common cancer sites such as prostate (135%), colo-rectum (36%), urinary bladder (59%) and kidney (70%) were higher in urban and tobacco-related cancers such as lung (12%), mouth (9%) and esophagus (4%) were higher in rural Trivandrum. Fatality ratio was slightly higher in rural for cancers such as pharynx, colo-rectum, larynx, prostate, urinary bladder, brain and multiple myeloma. Age-specific incidence rates were almost similar in both the urban and rural populations.

Data quality indicators such as microscopic diagnosis and 'DCO' were almost similar in both urban and rural population. Moreover, the distances by road between the three main oncology centers (2 governments and 1 private) in urban Trivandrum and the rest of the regions are small. Also, in the present analysis, all rural population is not strictly rural as 34% are urban, urban-rural difference in education among men in Trivandrum is very minimal. Considering all these aspects, it is possible that there is equality in access to these oncology services.

Cancer incidence is generally reported as higher in urban population world-wide [4]. In the present analysis, prostate cancer incidence and mortality was higher in urban Trivandrum, compared to their rural counterparts. In urban Trivandrum, incidence of this disease was observed to be the highest in the country [7]. Studies have demonstrated that prostate cancer incidence was higher in urban regions of Sweden [8], Italy [9] and Spain [10], due to zones close

Table 2. Urban-Rural comparison of Male Cancer Mortality & Fatality ratio in Trivandrum (2012-2014)

Site	Number U/R	CMR			ASMR		RR (95% CI)	p-value	Fatality (%)	
		U	R	Diff	U	R			U	R
All sites	1159/ 1974	69.4	64	5.4	56.2	52.3	1.07 (1.00,1.16)	<0.001*	38.3	43.0
Oral cavity (lip, mouth & tongue) & pharynx										
Oral cavity	112/ 212	6.53	6.87	-0.34	5.19	5.53	0.94 (0.75,1.18)	0.042*	39.0	41.5
Tongue	52/ 86	3.12	2.89	0.23	2.44	2.33	1.05 (0.74,1.48)	0.710	34.7	36.4
Mouth	57/ 122	3.14	3.99	-0.85	2.75	3.21	0.86 (0.63,1.17)	0.303	44.2	46.7
Pharynx	37/ 81	2.22	2.63	-0.41	1.74	2.14	0.81 (0.55,1.20)	0.442	42.1	51.6
Digestive organs										
Esophagus	40/ 69	2.39	2.24	0.15	1.97	1.82	1.08 (0.73,1.60)	0.141	50.6	46.0
Stomach	57/ 76	3.41	2.46	0.95	2.75	2.02	1.36 (0.97,1.92)	0.011*	47.9	44.4
Colo-rectum	54/ 98	3.24	3.18	0.06	2.59	2.61	0.99 (0.71,1.38)	0.121	21.1	28.2
Liver	55/ 73	3.29	2.37	0.92	2.66	1.93	1.38 (0.97,1.96)	0.011*	44.4	40.1
Pancreas	27/ 46	1.61	1.49	0.12	1.27	1.21	1.05 (0.65,1.69)	0.216	48.2	45.1
Respiratory organs										
Larynx	35/ 62	2.09	2.01	0.08	1.71	1.62	1.06 (0.70, 1.60)	0.191	27.8	32.3
Lung	176/ 313	10.54	10.15	0.39	8.25	7.52	1.10 (0.91,1.32)	0.004*	55.0	46.8
Genital organs										
Prostate	48/ 54	2.88	1.75	1.13	2.32	1.4	1.66 (1.12,2.44)	0.005*	15.5	22.6
Urinary tract organs										
Kidney	8/ 10	0.48	0.32	0.16	0.38	0.25	1.52 (0.60,3.85)	0.303	10.0	11.5
Bladder	17/ 33	1.02	1.07	-0.05	0.8	0.85	0.94 (0.52,1.69)	0.196	12.8	21.3
Brain, other central nervous system (CNS) & Thyroid										
Brain & CNS	20/ 35	1.19	1.13	0.06	1.01	0.96	1.05 (0.61,1.82)	0.310	30.3	39.8
Thyroid	7/ 9	0.42	0.29	0.13	0.35	0.24	1.46 (0.54, 3.92)	0.351	8.1	7.8
Hematological malignancies										
Lymphoma	37/ 45	2.22	1.45	0.77	1.89	1.19	1.59 (1.03,2.45)	0.022*	23.8	20.6
Myeloma	26/ 40	1.56	1.29	0.27	1.23	1.05	1.17 (0.71,1.92)	0.151	28.3	37.7
Leukaemia	47/62	2.82	2.04	0.78	2.54	1.91	1.33 (0.91,1.94)	0.018*	47.0	35.6

*statistically significant at 5% level; CMR: crude; ASMR: Age-standardised rates

to diagnostic services and also due to better cancer screening. However, in the present study population, higher incidence in urban Trivandrum need not be due to the prostate specific antigen testing as it is not practicing in both the regions. It could be due to differences in some life-style factors as differences in health care between urban and rural population is minimal.

Higher incidence for urinary bladder and kidney cancers in urban Trivandrum might be due to the fact that during the diagnosis of prostate cancer, several examinations are performed in order to evaluate its behavior and extension; such examinations may also detect the prevalence of other genito-urinary cancers. Studies have reported that prostate and bladder synchronous simultaneous cancers are found in cystectomies performed for bladder carcinomas: older patients undergoing radical cystectomy due to bladder cancer usually also showed an incidental finding of prostate cancer [11,12].

Colo-rectal cancer incidence was higher in urban Trivandrum than the rural counterparts and the rate in urban Trivandrum was the highest in the country [7]. Studies have reported that colo-rectal cancer is common in developed countries [4] and higher incidence in urban population, mainly due to screening programme. However, higher incidence of this cancer in urban Trivandrum is not due to screening programme, as the same has not been practicing in both the regions. The difference could be due to difference in life-style and certain dietary factors. Even though there was difference in incidence, almost similar mortality rate was observed in both

regions. Some studies have observed increased risk of death for colon cancer among rural residents in Georgia, US [13].

Unlike in other studies, a higher incidence and mortality due to stomach cancer was observed in urban Trivandrum. Incidence from this type of malignancy in rural areas is higher world-wide and global trends of stomach cancer have been declining during the past 40 years [14,15]. This is an intrinsic feature of the dietary transition brought about by the advances in food preservation, the introduction of refrigerators and the overall improvement in the quality of nutrition.

Thyroid cancer incidence showed 36% higher risk in urban areas than rural males in Trivandrum. Medical exposure to radiation has drastically increased, corresponding with more frequent use of CT scans and nuclear medicine [16,17]. Therefore, a possible explanation for higher risk in urban areas worth investigating is increased exposure to medical radiation at a young age due to easier access to medical facilities using CT scans or other radioactive medical techniques. Another possible explanation may be higher rates of incidental diagnosis in urban areas. Highly sensitive imaging techniques allow for the incidental detection of many non-palpable nodules, the majority of which may be benign, during imaging of the neck area.

Contrary to the higher incidence of above sites in the urban zone, higher incidence of lung, mouth and esophageal cancers were observed in rural population. These might be related to higher smoking habits among rural males. Even though the prevalence of tobacco use is low in Kerala, it is reported that its use is higher among rural population as compared to urban and hence this higher use of tobacco might be the reason for the higher incidence of these cancers in rural [18].

Fatality ratio (mortality/ incidence) for overall and specific sites such as oral cavity, pharynx, larynx, colo-rectum, prostate, urinary bladder and myeloma was observed slightly higher in rural than the urban population. This might be due to a higher proportion of late stage at diagnosis among rural population. Several studies have investigated the relationship between rural areas and cancer. One of the most important findings is that rural residents are generally diagnosed at a later stage and have decreased survival rates as opposed to their urban counterparts [19,20]. This has been shown for many types of cancers in both developed and developing countries, including colo-rectal and prostate adenocarcinomas [21-24].

Special efforts were made for obtaining cancer deaths in Trivandrum due to the limitation in obtaining accurate cause of death. Still, overall mortality rates were low compared to the estimated national figures [14] in both urban and rural. One possibility might be due to the high incidence of cancers such as thyroid, urinary bladder etc., which have comparatively better prognosis. However, steps are to be initiated by the vital statistics offices for measuring accurate burden of diseases including cancer. The present study focused only in two regions that represent only a small portion of the total population in Kerala. It would be interesting to assess the differences in the health care access between the urban-rural populations in Kerala as we have made only assumptions based on the results of registry quality indicators.

In conclusion, a distinction is drawn in cancer incidence and mortality between urban and rural male population in Trivandrum. Higher incidence of prostate, colo-rectal and genitor-urinary cancers might be due to some changes in life-style factors, more similar to "western" jurisdictions and partly due to improved health care access in urban population. A higher incidence of tobacco-related cancers and a higher proportion of cases diagnosed in advanced stages in rural than the urban population necessitates more awareness programmes particularly tobacco-awareness in rural population. Although this study focuses only in two regions that represent a small portion of the total population in Kerala, it may well serve as a global paradigm. More research is required to assess the differences in the health care access between urban and rural populations and to establish a clear picture of the epidemiological map that will confirm the hypothesis of rural/ urban disparities in cancer incidence and mortality to a wider scale.

Acknowledgement

The financial and technical support of the National Centre for Disease Informatics, Indian Council of Medical Research, Government of India, the two administrative letters (D.O.No.398/ HS/2011 dated 28-12-2011 & D.O No. 64/ACS/2016/ H&FWD dated 19-07-2016, Government of Kerala, the co-operation of all the Government and Private hospitals, Pathology laboratories and Vital Statistics Offices in the district and the dedicated effort of the staff of the cancer registry are greatly acknowledged towards the compilation of cancer statistics in the Trivandrum district.

References

1. Sabesan S, Piliouras P (2009) Disparity in cancer survival between urban and rural patients: how can clinicians help reduce it? Rural Remote Health 9(3): 1146.
2. Lin JD, Zhang L, Xu ZZ, Xu LC (2010) Research on burden of chronic diseases among rural-urban residents in Xuzhou. Public Health 124(6): 345-349.
3. Hendryx M, Fedorko E, Halverson J (2010) Pollution sources and mortality rates across rural-urban areas in the United States. J Rural Health 26(4): 383-391.
4. Forman D, Bray F, Brewster DH, Gombe Mbalawa C, Kohler B et al. (2014). Cancer Incidence in Five Continents, Vol. X. IARC Scientific Publication No. 164: International Agency for Research on Cancer. Lyon, France.
5. Takiar R, Shobana B (2009) Cancer incidence rates and the problem of denominators-a new approach in Indian cancer registries. Asian Pac J Cancer Prev 10: 123-126.
6. Dos Santos Silva (1999) Cancer Epidemiology: Principles and Methods. Lyon, France: International Agency for Research on Cancer.
7. National Cancer registry Programme (NCRP). Three Year Report of Population Based Cancer Registries 2012-2014. NCRP. 2016.
8. Stattin P1, Johansson R, Lodnert R, Andrén O, Bill-Axelsson A et al. (2005) Geographical variation in incidence of prostate cancer in Sweden. Scad J Urol Nephrol 39: 372-379.

9. La Rosa F, Stracci F, Minelli L, Mastrandrea V (2003) Epidemiology of prostate cancer in the Umbria region of Italy: evidence of opportunistic screening effects. Urology 62: 1040-1044.

10. Ocaña-Riola R, Sánchez-Cantalejo C, Rosell J, Sánchez- Cantalejo E (2004) Daponte A. Socio-economic level, farming activities and risk of cancer in small areas of Southern Spain. Eur J Epidemiol 19: 643-650.

11. Cassetti T, Scheibel M, Stracci F, Minelli L, La Rosa F (2007) Incidence of multiple primary bladder and prostate cancer in central region of Italy. Umbria, 1994-2004. Tumori 93: 242- 243.

12. Stracci F, Canosa A, Minelli L, Petrinelli A M, Cassetti T (2007) Cancer mortality trends in the Umbria region of Italy 1978–2004: a joinpoint regression analysis. BMC Cancer 7(10).

13. Hines RB, Markossian TW (2012) Differences in late-stage diagnosis, treatment, and colorectal cancer-related death between rural and urban African Americans and Whites in Georgia. *J Rural Health* 28(3): 296–305.

14. Ferlay J, Soerjomataram I, Ervik M, Dikshit R, Eser S, Mathers C et al. (2014) GLOBOCAN 2012 v1.1, Cancer Incidence and Mortality Worldwide: IARC CancerBase No. 11 [Internet]. Lyon, France: International Agency for Research on Cancer.

15. Ferro A, Peleteiro B, Malvezzi M, Bosetti C, Bertuccio P et al. (2014) Worldwide trends in gastric cancer mortality (1980-2011), with predictions to 2015, and incidence by subtype. Eur J Cancer ; 50: 1330-1344.

16. Mettler FA Jr, Huda W, Yoshizumi TT, Mahesh M (2008) Effective doses in radiology and diagnostic nuclear medicine: a catalog. Radiology 248(1): 254-263.

17. Enewold L, Zhu K, Ron E, Aizen J. Marrogi, Stojadinovic A et al. (2009) George E. Peoples, Susan S. Devesa. Rising thyroid cancer Incidence in the United States by demographic and tumor characteristics, 1980-2005. Cancer Epidemiology Biomarkers & Prevention 18 (3): 784 -791.

18. GATS India. Global adult tobacco survey India, 2009-2010. International Institute for Population Sciences (IIPS), Mumbai and Ministry of Health and Family Welfare, Government of India.

19. Doescher MP, Jackson JE (2009) Trends in cervical and breast cancer screening practices among women in rural and urban areas of the United States. J Public Health Manag Pract 15(3): 200-209.

20. Stamenić V, Strnad M (2011) Urban-rural differences in a population-based breast cancer screening program in Croatia. Croat Med J 52(1): 76-86.

21. Benuzillo JG, Jacobs ET, Hoffman RM, Heigh RI, Lance P et al. (2009) Rural-urban differences in colorectal cancer screening capacity in Arizona. J Community Health 34(6): 523-528.

22. Stamatiou K, Skolarikos A (2009) Rural residence and prostate cancer screening with prostate-specific antigen. Rural Remote Health 9(2): 1227.

23. Celaya MO, Berke EM, Onega TL, Gui J, Riddle BL et al. (2010) Breast cancer stage at diagnosis and geographic access to mammography screening (New Hampshire, 1998-2004). Rural Remote Health 10(2): 1361

24. Jemal A, Ward E, Wu X, Martin HJ, McLaughlin CC et al. (2005) Geographic patterns of prostate cancer mortality and variations in access to medical care in the United States. Cancer Epidemiol Biomarkers Prev14(3): 590-595.