

# Five year record on Cancer Incidence from a Diagnostic Centre in Mizoram, Northeast India

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## ABSTRACT

Cancer has become leading cause of death in Northeast Indian population. The main reason being poor knowledge of prevention and diagnosis combined with modern lifestyle of the Mizo population. All cancers have been reported in Mizo population including the cancers of stomach, cervix, lungs, breast, oesophagus, rectum, prostate, liver, bladder, oral etc. The cause of such high incidence rates of these cancers may be inherited or genetic and environmental factors such as life style and food habits, especially high consumption of tobacco and alcohol. A peculiar habit of tobacco smoke-infused water (Tuibur) is also in practice in this population. In view of these facts, the present article describes the status of various types of cancers in Mizo population. Besides, attempts have been made to describe the main causes of cancer in this population with their frequency and grading. In this study, increasing number of cancer patients in different age group was observed from 2011 – 2015. The highest incidence of cancer was observed in the patients with age group 50 - 60, followed by age groups above 60 years. In age group 20-30 years, the breast and cervix cancers were more prevalent from 2011 – 2015. In middle age group (30-40 and 40-50 years), the cervix, stomach and oesophagus cancers were more prevalent. The common type of cancer in female includes cervical cancer, followed by breast cancer which is shown to be increasing with age of the patients and also increasing each year within this 5 year period from 2011 – 2015. In 2014 and 2015, adenocarcinoma (AC) and squamous cell carcinoma (SCC) are both commonly seen. This study will help in understanding the etiology of cancer and also in developing preventive measures in future.

**KEYWORDS:** Cancer Prevalence, life style habits, Adenocarcinoma, Squamous cell carcinoma, Mizo Population, Northeast India

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## INTRODUCTION

Cancer is a major public health problem in India. Cancer is the second and third most common cause of death in the developed and developing countries, respectively [Bener et al.,2008]. A large network of population based cancer registries in India, provides valuable data for cancer. Population-based survival comparisons for cancer between nine Asian countries showed that India has the lowest 5-year survival for most cancer sites; 5-year survival for breast cancer was 52% and for colorectal cancer was 28%, compared with 82% and 44% in China. Breast cancer (145000 cases per year), tobacco-related head and neck cancers (141000), cervical cancer (123000), lung cancer (70000), large bowel cancer (64000), and stomach cancer (63000) account for more than half of the burden, implying that prevention, along with early detection and treatment, are important interventions for cancer control [Bener et al.,2008]. About 70% cancer cases have been diagnosed, with little survival of the patients, over the last decades. The poor prospects of cancer survival indicates inadequate health care financing, and also because cancer diagnosis and treatment are becoming increasingly unaffordable for health-care systems in India as well as in many low-income and middle-income countries since it has centred on expensive diagnostic and staging investigations such as imaging, and on specialised treatments and costly drugs. Most frequently observed cancers in Indian population are lungs, breast, colon, rectum, stomach and liver [NCRP, 2010; Rao, 1998; Murthy et al., 2004]. It is important to study the status of cancers in India so that advance measures may be taken to control this havoc in near future. In view of these facts, attempts have been made to study the status of cancers in India including its causes, preventive

measures, effect on Indian economy and comparison with global scenario.

## DATA SOURCES AND METHODS

### *Study area*

The study area Mizoram is flanked by Bangladesh on the west and Myanmar on the east and south. The total area is 21,081 sq. km. It mainly consists of 8 districts, namely Aizawl, Lunglei, Champhai, Lawngtlai, Mamit, Kolasib, Serchhip and Saiha. The total population of the State is 10,97,206 with about 5,55,339 males and 5,41,867 females as per the 2011 census. Patients from other districts also visit the capital city, Aizawl for diagnosis and treatment.

### *Data collection*

Genesis Laboratory, Aizawl acts as the major diagnostic facility of cancer. Ethical approval was obtained from the Institutional Ethics Committee. The study subjects included 1,477 cancer patients diagnosed/registered in Genesis Laboratory, Aizawl between 2011 – 2015. This data included different types of cancer and the type of cells being affected both in males and females, within different age groups and its staging on the basis of clinical symptoms and histopathology at the Genesis Laboratory, Aizawl, Mizoram. The patients coming from all the different districts of Mizoram were included in this analysis.

### *Statistical analysis*

The frequencies of the collected data were represented according to their age group, type of cancer, staging and sex ratio. The association in each group was estimated using odds ratios (ORs) and 95% confidence intervals (CIs). The association of various cancers and stages of the patients was tested for Hardy–Weinberg equilibrium by a chi-square test with one degree of freedom (df).

Table 1. List of various cancers year wise, stratified by age group.

Age group	Cancer type	No (%)	Male	Female	ORs (95% CI)	P value
<b>2011</b>						
20-30	Breast <sup>a</sup>	3 (60)	0	3	2.00 (0.42 - 9.33)	0.0497
	Liver <sup>b</sup>	1 (20)	0	1	0.20 (0.03 - 1.29)	
	Colon <sup>b</sup>	1 (20)	0	1	0.20 (0.03 - 1.29)	
31-40	Breast <sup>ab</sup>	6(24)	0	6	0.31 (0.12 - 0.76)	0.0159
	Uterus <sup>b</sup>	1(4)	0	1	0.92 (0.42 - 1.98)	
	Cervix <sup>a</sup>	10(40)	0	10	0.13 (0.04 - 0.42)	
	Endometrium <sup>b</sup>	2(8)	0	2	0.08 (0.02 - 0.33)	
	Colon <sup>b</sup>	1(4)	0	1	0.04 (0.007 - 0.24)	
	Stomach <sup>b</sup>	1(4)	1	1	0.04 (0.007- 0.24)	
41-50	Cervix <sup>a</sup>	13(22.4)	0	13	0.08 (0.03 - 0.18)	0.0001
	Tongue <sup>c</sup>	1(1.72)	1	0	0.26 (0.15 - 0.45)	
	Stomach <sup>a</sup>	13(22.4)	6	7	0.12 (0.06 - 0.25)	
	Oesophagus <sup>ab</sup>	11(18.96)	10	1	0.01 (0.002- 0.06)	
	Pyriiform fossa <sup>bc</sup>	3(5.17)	3	0	0.17 (0.09 - 0.32)	
	Breast <sup>abc</sup>	4(6.89)	0	4	0.03 (0.01 - 0.11)	
	Nasopharynx <sup>bc</sup>	3(5.17)	1	2	0.03 (0.01 - 0.11)	
	Liver <sup>abc</sup>	4(6.89)	3	1	0.01 (0.002- 0.06)	
	Lung <sup>abc</sup>	5(8.62)	3	2	0.01 (0.002- 0.06)	
51-60	Oesophagus <sup>c</sup>	1(2.56)	0	1	0.04 (0.01 - 0.12)	0.0016
	Pharynx <sup>ab</sup>	13(33.33)	2	11	0.20 (0.11 - 0.37)	
	Breast <sup>abc</sup>	7(17.94)	7	0	0.10 (0.04 - 0.21)	
	Uterus <sup>a</sup>	14(35.89)	13	1	0.22 (0.12 - 0.40)	
	Cervix <sup>c</sup>	1(2.56)	1	0	0.01 (0.002- 0.07)	
	Lung <sup>c</sup>	3(7.69)	2	1	0.04 (0.01 - 0.12)	
	Stomach <sup>c</sup>	3(7.69)	2	1	0.04 (0.01 - 0.12)	
	Nasopharynx <sup>c</sup>	1(2.56)	1	0	0.01 (0.002- 0.07)	
	Tonsil <sup>c</sup>	1(2.56)	1	0	0.01 (0.01 - 0.07)	
	Endometrium <sup>c</sup>	1(2.56)	1	0	0.01 (0.01 - 0.07)	
	Liver <sup>c</sup>	1(2.56)	0	1	0.01 (0.01 - 0.07)	
	Pyriiform fossa <sup>c</sup>	1(2.56)	0	1	0.01 (0.01 - 0.07)	
	> 60	Stomach <sup>a</sup>	26(29.88)	14	12	
Oesophagus <sup>ab</sup>		3(3.44)	3	0	0.03 (0.005- 0.18)	
Nasopharynx <sup>ab</sup>		3(3.44)	3	0	0.73 (0.37 - 1.45)	
Tonsil <sup>b</sup>		1(1.14)	1	0	0.10 (0.03 - 0.30)	
Breast <sup>ab</sup>		3(3.44)	0	3	0.06 (0.01 - 0.24)	
Cervix <sup>ab</sup>		3(3.44)	0	3	0.03 (0.005- 0.18)	
Pyriiform fossa <sup>b</sup>		1(1.14)	1	0	0.10 (0.03 - 0.30)	
Tongue <sup>b</sup>		1(1.14)	1	0	0.03 (0.005- 0.18)	
Urinary Bladder <sup>b</sup>		1(1.14)	1	0	0.03 (0.005- 0.18)	
Epiglottis <sup>b</sup>		1(1.14)	1	0	0.03 (0.005- 0.18)	
Lung <sup>b</sup>		26(29.88)	14	12	0.03 (0.005- 0.18)	
Liver <sup>a</sup>		18(20.68)	11	7	0.03 (0.005- 0.18)	
<b>2012</b>						
20-30	Breast <sup>a</sup>	1(12.5)	0	1	0.05 (0.01 - 0.34)	0.0119
	Stomach <sup>a</sup>	2(25)	0	2	0.12 (0.03 - 0.48)	
	Colon <sup>a</sup>	1(12.5)	0	1	0.05 (0.01 - 0.34)	
	Cervix <sup>a</sup>	3(37.5)	0	3	0.05 (0.01 - 0.34)	
	Nasopharynx <sup>a</sup>	1(12.5)	0	1	1.25 (0.50 - 3.07)	
31-40	Liver <sup>ab</sup>	6(19.35)	2	4	0.09 (0.03 - 0.29)	0.0012

	Cervix <sup>a</sup>	7(22.58)	0	7	0.13 (0.04 – 0.36)	
	Breast <sup>abc</sup>	3(9.6)	0	3	0.25 (0.11 – 0.58)	
	Tongue <sup>c</sup>	1(3.22)	1	0	0.03 (0.005– 0.17)	
	Stomach <sup>bc</sup>	2(6.45)	1	1	0.03 (0.005– 0.17)	
	Oesophagus <sup>a</sup>	7(22.58)	6	1	0.06 (0.01 – 0.23)	
	Uterus <sup>c</sup>	1(3.22)	0	1	0.03 (0.005– 0.17)	
	Tonsil <sup>c</sup>	1(3.22)	1	0	0.06 (0.01 – 0.23)	
	Thyroid <sup>c</sup>	1(3.22)	0	1	0.03 (0.005– 0.17)	
	Pyriform fossa <sup>c</sup>	1(3.22)	1	0	0.41 (0.20 – 0.85)	
	Pharynx <sup>c</sup>	1(3.22)	1	0	0.03 (0.005– 0.17)	
<b>41-50</b>	Liver <sup>a</sup>	10(17.24)	5	5	0.18 (0.09 – 0.36)	0.0001
	Lung <sup>abcd</sup>	5(8.62)	5	0	0.18 (0.09 – 0.36)	
	Oesophagus <sup>ab</sup>	9(15.51)	8	1	0.20 (0.10 – 0.40)	
	Stomach <sup>abc</sup>	8(13.79)	8	0	0.01 (0.003– 0.10)	
	Nasopharynx <sup>bcd</sup>	3(5.17)	2	1	0.03 (0.009– 0.13)	
	Cervix <sup>abcd</sup>	7(12.06)	0	7	0.05 (0.01 – 0.16)	
	Vocal Cord <sup>d</sup>	1(1.72)	1	0	0.03 (0.009– 0.13)	
	Tonsil <sup>d</sup>	1(1.72)	1	0	0.01 (0.003– 0.10)	
	Larynx <sup>d</sup>	1(1.72)	1	0	0.01 (0.003– 0.10)	
	Uterus <sup>d</sup>	1(1.72)	0	1	0.01 (0.003– 0.10)	
	Pyriform fossa <sup>d</sup>	1(1.72)	1	0	0.09 (0.03 – 0.22)	
	Breast <sup>d</sup>	7(12.06)	0	7	0.11 (0.05 – 0.26)	
	Mouth <sup>d</sup>	1(1.72)	1	0	0.03 (0.009– 0.13)	
	Colon <sup>cd</sup>	2(3.44)	2	0	0.03 (0.009– 0.13)	
<b>51-60</b>	Lung <sup>bc</sup>	9(9.57)	5	4	0.10 (0.05 – 0.21)	0.0001
	Liver <sup>c</sup>	4(4.25)	2	2	0.47 (0.30 – 0.74)	
	Stomach <sup>a</sup>	29(30.85)	17	12	0.35 (0.21 – 0.57)	
	Tongue <sup>c</sup>	2(2.12)	2	0	0.05 (0.01 – 0.13)	
	Pyriform fossa <sup>c</sup>	4(4.25)	4	0	0.02 (0.006– 0.09)	
	Caecum <sup>c</sup>	2(2.12)	2	0	0.02 (0.006– 0.09)	
	Oesophagus <sup>ab</sup>	20(21.27)	18	2	0.01 (0.002– 0.06)	
	Nasopharynx <sup>c</sup>	1(1.06)	0	1	0.01 (0.002– 0.06)	
	Thyroid <sup>c</sup>	1(1.06)	0	1	0.02 (0.006– 0.09)	
	Pharynx <sup>c</sup>	2(2.12)	2	0	0.07 (0.03 – 0.17)	
	Tonsil <sup>c</sup>	3(3.19)	2	1	0.03 (0.01 – 0.11)	
	Cervix <sup>c</sup>	3(3.19)	0	3	0.01 (0.002– 0.06)	
	Uterus <sup>c</sup>	1(1.06)	1	0	0.02 (0.006– 0.09)	
	Colon <sup>c</sup>	1(1.06)	0	1	0.01 (0.002– 0.06)	
	Breast <sup>bc</sup>	7(7.44)	1	6	0.01 (0.002– 0.06)	
	Epiglottis <sup>c</sup>	3(3.19)	3	0	0.01 (0.002– 0.06)	
<b>&gt;60</b>	Lung <sup>a</sup>	37(33.33)	15	22	0.04 (0.01 – 0.15)	0.0779
	Liver <sup>b</sup>	10(9.00)	5	5	1.08 (0.62 – 1.87)	
	Nasopharynx <sup>b</sup>	4(3.60)	3	1	0.25 (0.12 – 0.49)	
	Stomach <sup>b</sup>	36(32.43)	23	13	0.06 (0.02 – 0.19)	
	Cervix <sup>b</sup>	5(4.50)	0	5	0.04 (0.01 – 0.15)	
	Epiglottis <sup>b</sup>	2(1.80)	1	1	0.02 (0.003– 0.11)	
	Oesophagus <sup>b</sup>	10(9.00)	10	0	0.08 (0.03 – 0.23)	
	Breast <sup>b</sup>	3(2.70)	0	3	0.02 (0.003– 0.11)	
	Pyriform fossa <sup>b</sup>	2(1.80)	2	0	0.02 (0.003– 0.11)	
<b>2013</b>						
<b>20-30</b>	Stomach <sup>a</sup>	3(50)	0	3	0.20 (0.03 – 1.29)	0.1889
	Breast <sup>a</sup>	1(16.67)	0	1	1.00 (0.23 – 4.33)	
	Tongue <sup>a</sup>	2(33.33)	2	0	0.50 (0.10 – 2.33)	

31-40	Cervix <sup>ab</sup>	12(21.42)	0	12	0.38 (0.21 – 0.71)	0.0002
	Nasopharynx <sup>c</sup>	1(1.78)	0	1	0.85 (0.49 – 1.47)	
	Oesophagus <sup>abc</sup>	8(14.28)	7	1	0.11 (0.45 – 0.27)	
	Tongue <sup>bc</sup>	4(7.14)	3	1	0.02 (0.003– 0.11)	
	Stomach <sup>bc</sup>	5(8.92)	3	2	0.02 (0.003– 0.11)	
	Breast <sup>a</sup>	14(25.00)	0	14	0.02 (0.003_ 0.11)	
	Larynx <sup>c</sup>	1(1.78)	1	0	0.04 (0.01 – 0.15)	
	Tonsil <sup>c</sup>	1(1.78)	0	1	0.04 (0.01 – 0.15)	
	Uterus <sup>bc</sup>	4(7.14)	0	4	0.02 (0.003– 0.11)	
41-50	Lung <sup>b</sup>	4(4.30)	0	4	0.31 (0.17 – 0.57)	0.0001
	Liver <sup>b</sup>	5(5.37)	2	3	0.61 (0.36 – 1.03)	
	Cervix <sup>ab</sup>	17(18.27)	0	17	0.20 (0.10 – 0.40)	
	Stomach <sup>ab</sup>	14(15.05)	10	4	0.01 (0.003– 0.10)	
	Caecum <sup>b</sup>	1(1.07)	0	1	0.01 (0.003– 0.10)	
	Uterus <sup>b</sup>	2(2.15)	0	2	0.05 (0.01 – 0.16)	
	Breast <sup>ab</sup>	12(12.90)	0	12	0.01 (0.003– 0.10)	
	Oesophagus <sup>a</sup>	27(29.03)	23	4	0.01 (0.003– 0.10)	
	Pharynx <sup>b</sup>	1(1.07)	1	0	0.07 (0.02 – 0.19)	
Bladder <sup>b</sup>	1(1.07)	0	1	0.01 (0.003– 0.10)		
51-60	Lung <sup>b</sup>	13(9.55)	7	6	0.06 (0.02 – 0.14)	0.0033
	Liver <sup>b</sup>	10(7.35)	5	5	0.25 (0.15 – 0.42)	
	Stomach <sup>a</sup>	37(27.20)	17	20	0.54 (0.35 – 0.83)	
	Epiglottis <sup>b</sup>	2(1.47)	2	0	0.06 (0.02 – 0.14)	
	Oesophagus <sup>a</sup>	35(25.73)	30	5	0.04 (0.01 – 0.12)	
	Tongue <sup>b</sup>	1(0.73)	1	0	0.02 (0.006– 0.08)	
	Cervix <sup>b</sup>	14(10.29)	0	14	0.02 (0.006– 0.08)	
	Skin <sup>b</sup>	1(0.73)	1	0	0.02 (0.006– 0.08)	
	Gall Bladder <sup>b</sup>	1(0.73)	0	1	0.02 (0.006– 0.08)	
	Tonsil <sup>b</sup>	1(0.73)	1	0	0.01 (0.002– 0.06)	
	Pharynx <sup>b</sup>	2(1.47)	2	0	0.01 (0.002– 0.06)	
	Breast <sup>b</sup>	6(4.41)	0	6	0.07 (0.03 – 0.16)	
	Pyriform fossa <sup>b</sup>	6(4.41)	6	0	0.01 (0.002– 0.06)	
	Tongue <sup>b</sup>	1(0.73)	1	0	0.01 (0.002– 0.06)	
	Colon <sup>b</sup>	4(2.94)	2	2	0.01 (0.002– 0.06)	
	Nasopharynx <sup>b</sup>	2(1.47)	2	0	0.01 (0.002– 0.06)	
Bladder <sup>b</sup>	1(0.73)	1	0	0.02 (0.006– 0.08)		
>60	Lung <sup>ab</sup>	40(25.64)	23	17	0.08 (0.01 – 0.49)	0.2237
	Liver <sup>b</sup>	8(5.12)	5	3	0.18 (0.04 – 0.73)	
	Stomach <sup>a</sup>	64(41.02)	49	15	0.18 (0.04 – 0.73)	
	Pyriform fossa <sup>b</sup>	1(0.64)	1	0	0.08 (0.01 – 0.49)	
	Nasopharynx <sup>b</sup>	2(1.28)	1	1	0.08 (0.01 – 0.49)	
	Tongue <sup>b</sup>	3(1.92)	1	2	0.08 (0.01 – 0.49)	
	Colon <sup>b</sup>	5(3.20)	3	2	0.08 (0.01 – 0.49)	
	Bladder <sup>b</sup>	7(4.48)	2	5	0.08 (0.01 – 0.49)	
	Cervix <sup>b</sup>	1(0.64)	0	1	0.08 (0.01 – 0.49)	
	Breast <sup>b</sup>	4(2.56)	1	3	0.08 (0.01 – 0.49)	
	Oesophagus <sup>b</sup>	19(12.17)	9	10	0.08 (0.01 – 0.49)	
<b>2014</b>						
20-30	Oesophagus <sup>ab</sup>	2(22.22)	2	0	0.22 (0.05 – 0.91)	0.0265
	Cervix <sup>a</sup>	4(44.44)	0	4	1.20 (0.38 – 3.70)	
	Breast <sup>ab</sup>	2(22.22)	0	2	0.10 (0.01 – 0.60)	
	Colon <sup>b</sup>	1(11.11)	0	1	0.10 (0.01 – 0.60)	
31-40	Liver <sup>b</sup>	1(2.85)	1	0	0.20 (0.08 – 0.48)	0.0037

	Breast <sup>ab</sup>	7(20.00)	1	6	0.75 (0.38 – 1.44)	
	Colon <sup>ab</sup>	3(8.57)	2	1	0.25 (0.11 – 0.55)	
	Oesophagus <sup>b</sup>	1(2.85)	1	0	0.06 (0.01 – 0.22)	
	Cervix <sup>a</sup>	12(34.28)	0	12	0.02 (0.005– 0.17)	
	Stomach <sup>ab</sup>	9(25.71)	3	6	0.02 (0.005– 0.17)	
	Pyriform fossa <sup>ab</sup>	2(5.71)	1	1	0.06 (0.01 – 0.22)	
	Nasopharynx <sup>b</sup>	1(2.85)	1	0	0.02 (0.005– 0.17)	
<b>41-50</b>	Liver <sup>bc</sup>	7(8.33)	6	1	0.13 (0.06 – 0.25)	<0.0001
	Cervix <sup>a</sup>	22(26.19)	0	22	0.48 (0.30 – 0.75)	
	Oesophagus <sup>ab</sup>	16(19.04)	15	1	0.16 (0.08 – 0.29)	
	Mouth <sup>c</sup>	1(1.19)	0	1	0.07 (0.03 – 0.16)	
	Epiglottis <sup>c</sup>	1(1.19)	0	1	0.22 (0.13 – 0.39)	
	Breast <sup>abc</sup>	10(11.90)	0	10	0.03 (0.01 – 0.10)	
	Stomach <sup>ab</sup>	16(19.04)	13	3	0.03 (0.01 – 0.10)	
	Colon <sup>bc</sup>	3(3.57)	2	1	0.04 (0.01 – 0.12)	
	Larynx <sup>c</sup>	1(1.19)	1	0	0.01 (0.002– 0.06)	
	Pyriform fossa <sup>bc</sup>	3(3.57)	3	0	0.01 (0.002– 0.06)	
	Uterus <sup>bc</sup>	2(2.38)	0	2	0.01 (0.002– 0.06)	
	Penis <sup>c</sup>	1(1.19)	1	0	0.01 (0.002– 0.06)	
<b>51-60</b>	Lung <sup>c</sup>	3(2.80)	2	1	0.06 (0.02 – 0.14)	<0.0001
	Liver <sup>c</sup>	8(7.47)	5	3	0.16 (0.08 – 0.29)	
	Ovary <sup>c</sup>	4(3.73)	1	3	0.36 (0.22 – 0.58)	
	Cervix <sup>bc</sup>	10(9.34)	0	10	0.62 (0.40 – 0.95)	
	Oesophagus <sup>ab</sup>	30(28.03)	26	4	0.03 (0.01 – 0.10)	
	Stomach <sup>a</sup>	31(28.97)	24	7	0.01 (0.002– 0.06)	
	Epiglottis <sup>c</sup>	1(0.93)	1	0	0.01 (0.002– 0.06)	
	Nasopharynx <sup>c</sup>	1(0.93)	0	1	0.02 (0.006– 0.08)	
	Pyriform fossa <sup>c</sup>	5(4.67)	5	0	0.03 (0.01 – 0.10)	
	Uterus <sup>c</sup>	2(1.86)	0	2	0.01 (0.002– 0.06)	
	Gall bladder <sup>c</sup>	2(1.86)	2	0	0.01 (0.002– 0.06)	
	Breast <sup>c</sup>	5(4.67)	0	5	0.01 (0.002– 0.06)	
<b>&gt;60</b>	Lung <sup>ab</sup>	33(25.00)	12	21	0.03 (0.01 – 0.10)	0.0008
	Liver <sup>bc</sup>	10(7.57)	7	3	0.10 (0.05 – 0.19)	
	Stomach <sup>a</sup>	45(34.09)	29	16	0.85 (0.58 – 1.25)	
	Vocal Cord <sup>c</sup>	1(0.75)	1	0	0.01 (0.005– 0.07)	
	Nasopharynx <sup>c</sup>	2(1.51)	2	0	0.15 (0.08 – 0.26)	
	Pyriform fossa <sup>c</sup>	1(0.75)	1	0	0.10 (0.05 – 0.19)	
	Colon <sup>c</sup>	6(4.54)	6	0	0.07 (0.03 – 0.14)	
	Oesophagus <sup>bc</sup>	13(9.84)	12	1	0.03 (0.01 – 0.10)	
	Cervix <sup>c</sup>	8(6.06)	0	8	0.009(0.001-0.05)	
	Breast <sup>c</sup>	4(3.03)	0	4	0.009(0.001-0.05)	
	Epiglottis <sup>c</sup>	2(1.51)	2	0	0.01 (0.005– 0.07)	
	Anus <sup>c</sup>	2(1.51)	0	2	0.009(0.001-0.05)	
	Vaginal Wall <sup>c</sup>	2(1.51)	1	1	0.009(0.001-0.05)	
<b>2015</b>						
<b>20-30</b>	Cervix <sup>a</sup>	5(45.45)	0	5	0.14 (0.03 – 0.56)	0.1132
	Thyroid <sup>b</sup>	2(18.18)	0	2	1.00(0.38 – 2.57)	
	Stomach <sup>b</sup>	1(9.09)	1	0	0.14 (0.03 – 0.56)	
	Breast <sup>b</sup>	2(18.18)	0	2	0.14 (0.03 – 0.56)	
	Ovary <sup>b</sup>	1(9.09)	0	1	0.14 (0.03 – 0.56)	
<b>31-40</b>	Liver <sup>ab</sup>	4(16.00)	4	0	0.34 (0.17 – 0.67)	<0.0001
	Breast <sup>ab</sup>	4(16.00)	0	4	1.15 (0.63 – 2.07)	
	Thyroid <sup>b</sup>	2(8.00)	1	1	0.07 (0.02 – 0.22)	

	Pyriform fossa <sup>b</sup>	1(4.00)	1	0	0.13 (0.05 – 0.32)	
	Bladder <sup>b</sup>	1(4.00)	1	0	0.04 (0.01 – 0.18)	
	Uterus <sup>b</sup>	1(4.00)	0	1	0.02 (0.004– 0.13)	
	Cervix <sup>a</sup>	9(36.00)	0	9	0.02 (0.004– 0.13)	
	Stomach <sup>b</sup>	2(8.00)	1	1	0.02 (0.004– 0.13)	
	Caecum <sup>b</sup>	1(4.00)	1	1	0.04 (0.01 – 0.18)	
<b>41-50</b>	Liver <sup>ab</sup>	7(12.28)	4	3	0.21 (0.13 – 0.34)	<0.0001
	Lung <sup>b</sup>	3(5.26)	2	1	0.38 (0.25 – 0.57)	
	Oesophagus <sup>a</sup>	14(24.56)	14	0	0.33 (0.22 – 0.50)	
	Stomach <sup>ab</sup>	8(14.03)	5	3	0.12 (0.06 – 0.21)	
	Breast <sup>ab</sup>	14(24.56)	0	14	0.02 (0.008– 0.07)	
	Cervix <sup>b</sup>	4(7.01)	0	4	0.008 (0.001-0.04)	
	Endometrium <sup>b</sup>	3(5.26)	0	3	0.04 (0.01 – 0.10)	
	Urinary Bladder <sup>b</sup>	1(1.75)	1	0	0.008 (0.001-0.04)	
	Mouth <sup>b</sup>	1(1.75)	1	0	0.04 (0.01 – 0.10)	
	Epiglottis <sup>b</sup>	1(1.75)	1	0	0.008 (0.001-0.04)	
	Uterus <sup>b</sup>	1(1.75)	0	1	0.01 (0.004 – 0.06)	
<b>51-60</b>	Liver <sup>ab</sup>	11(13.92)	4	7	0.06 (0.03 – 0.14)	<0.0001
	Lung <sup>abc</sup>	9(11.39)	4	5	0.18 (0.10 – 0.30)	
	Stomach <sup>a</sup>	15(18.98)	8	7	0.30 (0.20 – 0.47)	
	Breast <sup>bc</sup>	5(6.32)	0	5	0.11 (0.06 – 0.20)	
	Thyroid <sup>bc</sup>	2(2.53)	1	1	0.009(0.001-0.05)	
	Oesophagus <sup>a</sup>	16(20.25)	16	0	0.02 (0.009– 0.08)	
	Pyriform fossa <sup>bc</sup>	4(5.06)	4	0	0.22 (0.13 – 0.35)	
	Gall Bladder <sup>c</sup>	1(1.26)	0	1	0.05 (0.02 – 0.12)	
	Endometrium <sup>bc</sup>	3(3.79)	0	3	0.07 (0.03 – 0.15)	
	Bladder <sup>bc</sup>	2(2.53)	2	0	0.01 (0.005– 0.06)	
	Tongue <sup>c</sup>	1(1.26)	1	0	0.05 (0.02 – 0.12)	
	Cervix <sup>bc</sup>	4(5.06)	0	4	0.009(0.001-0.05)	
	Pharynx <sup>c</sup>	1(1.26)	1	0	0.009(0.001-0.05)	
	Epiglottis <sup>c</sup>	1(1.26)	0	1	0.009(0.001-0.05)	
<b>&gt;60</b>	Liver <sup>bc</sup>	11(11.70)	8	3	0.03 (0.01 – 0.10)	
	Lung <sup>a</sup>	28(29.78)	15	13	0.64 (0.43 – 0.95)	
	Epiglottis <sup>c</sup>	1(1.06)	1	0	0.10 (0.05 – 0.19)	
	Stomach <sup>ab</sup>	25(26.59)	15	10	0.17 (0.10 – 0.29)	
	Oesophagus <sup>bc</sup>	11(11.70)	8	3	0.15 (0.08 – 0.26)	
	Caecum <sup>c</sup>	1(1.06)	0	1	0.01 (0.005– 0.07)	
	Breast <sup>c</sup>	2(2.12)	0	2	0.02 (0.009– 0.08)	
	Larynx <sup>c</sup>	1(1.06)	1	0	0.01 (0.005– 0.07)	
	Pharynx <sup>c</sup>	1(1.06)	1	0	0.009(0.001-0.05)	
	Bladder <sup>c</sup>	1(1.06)	1	0	0.01 (0.005– 0.07)	
	Colon <sup>c</sup>	4(4.25)	3	1	0.009(0.001-0.05)	
	Pyriform fossa <sup>c</sup>	2(2.12)	2	0	0.009(0.001-0.05)	
	Cervix <sup>c</sup>	3(3.19)	0	3	0.009(0.001-0.05)	
	Ureter <sup>c</sup>	1(1.06)	1	0	0.01 (0.005– 0.07)	
	Gall Bladder <sup>c</sup>	2(2.12)	1	1	0.03 (0.01 – 0.10)	

OR – Odds Ratio CI – Confidence Interval

a, b, c, ab, bc – level of significance using Duncan's ANOVA Test

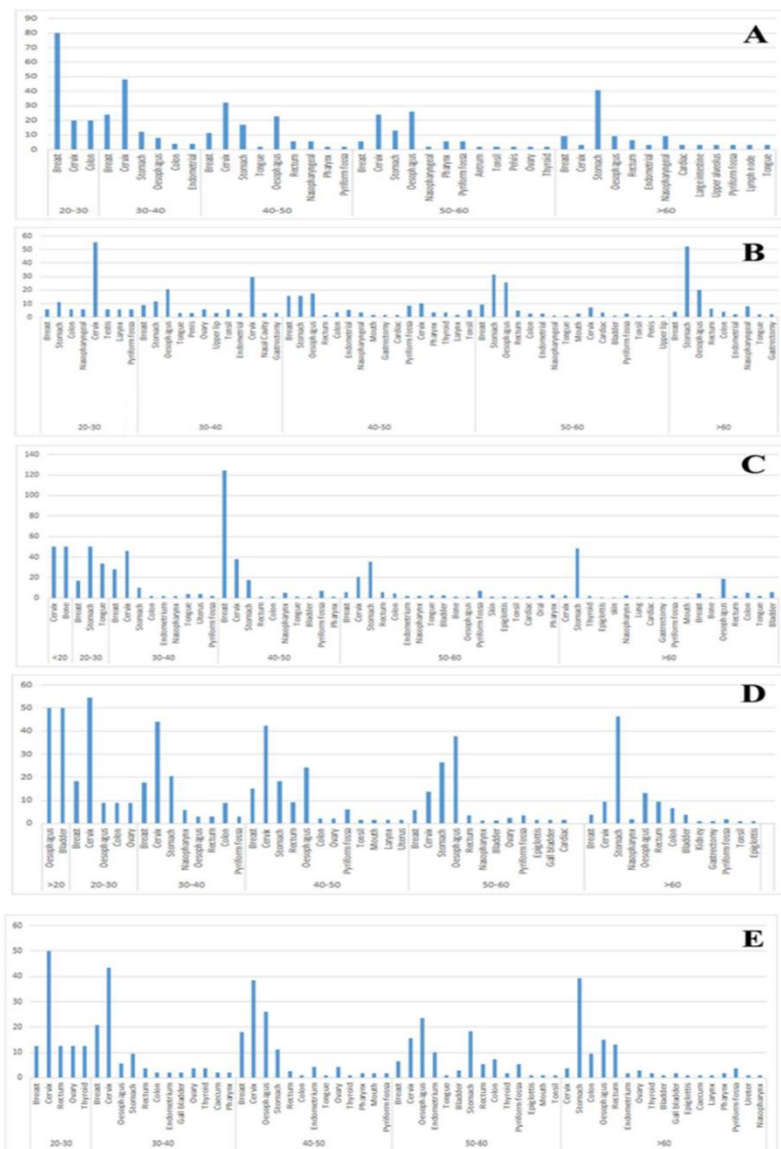
## RESULTS

A total of 1,477 patients with malignancy reported to Genesis Laboratory (Aizawl) from 2011 – 2015. The highest incidence of cancer was observed in

the patients with age group 50 - 60 (423), followed by age groups above 60 (399). This shows an increase in the disease with increase in age. There was a statistical significance observed between the

age group and different types of cancers. In 2011, 2012 and 2014, the age group 20-30, 30-40, 40 – 50 and 50 to 60 are shown to be significant, whereas in 2013 and 2014 the age group 30-40, 40-50 and 50-60 shows significance (Table 1). Remarkably, only in 2014 the age group more than 60 years of age was significant with different cancer types. In age group 20-30, breast and cervix cancer were more prevalent, throughout all the years. In middle age group (30-40 and 40-50) cervix, stomach and oesophagus cancer were more prevalent, throughout all the years. In older age group (41 to 60 and >60), stomach cancer was

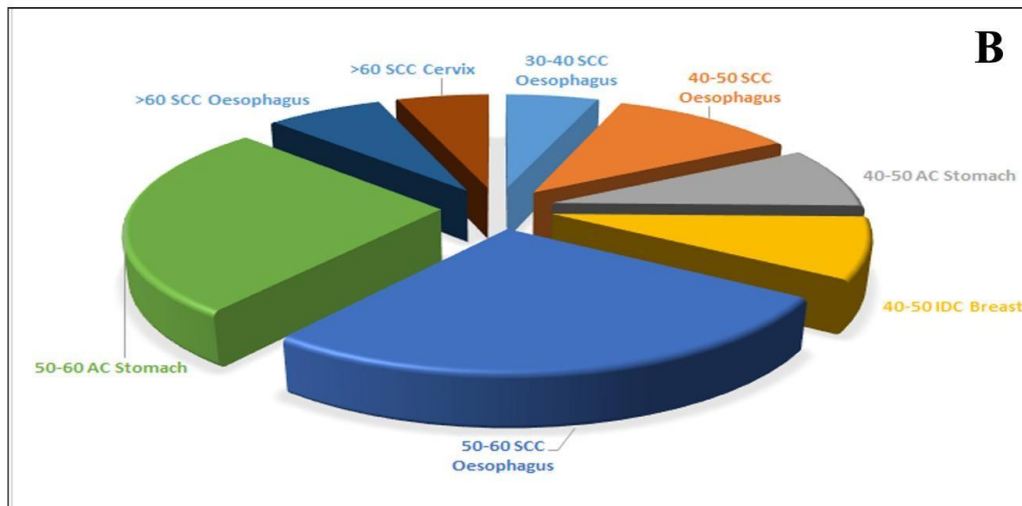
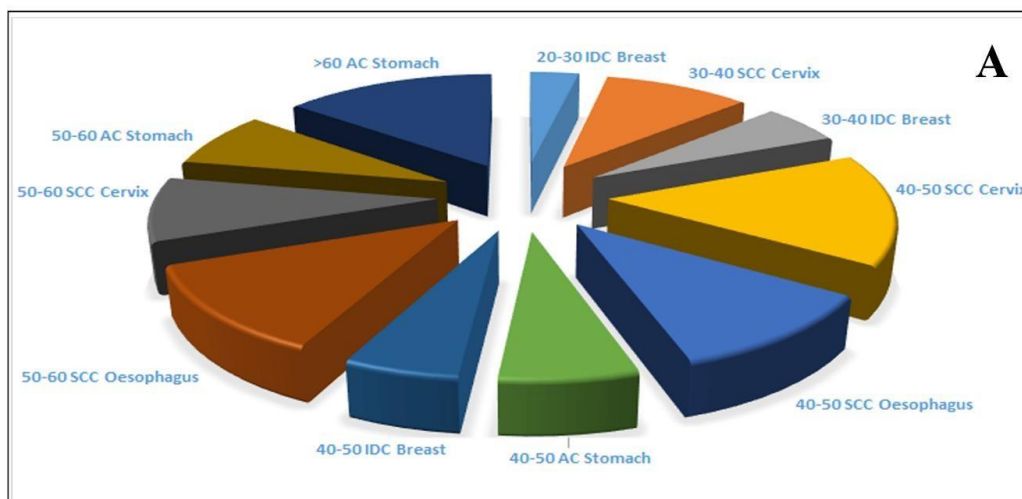
the leading cancer followed by oesophagus cancer in throughout all the years. Cancer is dominant in Females (778) than in males (710). The common type of cancer in female includes cervical cancer, followed by breast cancer which is shown to be increasing with age of the patients and also increasing each year within this 5 year period from 2011 – 2015 (Figure 1). In males, stomach cancer is the most prevalent type of cancer followed by oesophagus cancer. Both the type of cancers are found commonly in the patients with age 40 yrs and above.



**Figure 1.** Various Cancer Frequency based on Age group for the years 2011 (A), 2012 (B), 2013 (C), 2014 (D), 2015 (E).



Different types of cells were involved with the different types of cancers. In 2011, Squamous cell carcinoma (SCC) was the most common pathological variety of cancer in males, followed by Adenocarcinoma (AC). In 2013, Moderately Differentiated Squamous Cell Carcinoma (MDSCC) had the highest percentage of occurrence. In 2014 and 2015 AC and SCC are both commonly seen. In the year 2011 the adenocarcinoma stomach and squamous cell carcinoma oesophagus showed prevalence in older age group, but in middle age group the squamous cell carcinoma cervix was the leading cancer group (Figure 2). Adenocarcinoma stomach and squamous cell carcinoma oesophagus were the ladder of all the cancer types for the year of 2012. In 2013 the older age group had significant growth than other age group, because the adenocarcinoma stomach and moderately differentiated squamous cell carcinoma in oesophagus were the leading cancer. The same prevalence was also observed for the year of 2014 and 2015. But for 2015 other types of cancers prevalence was also observed.



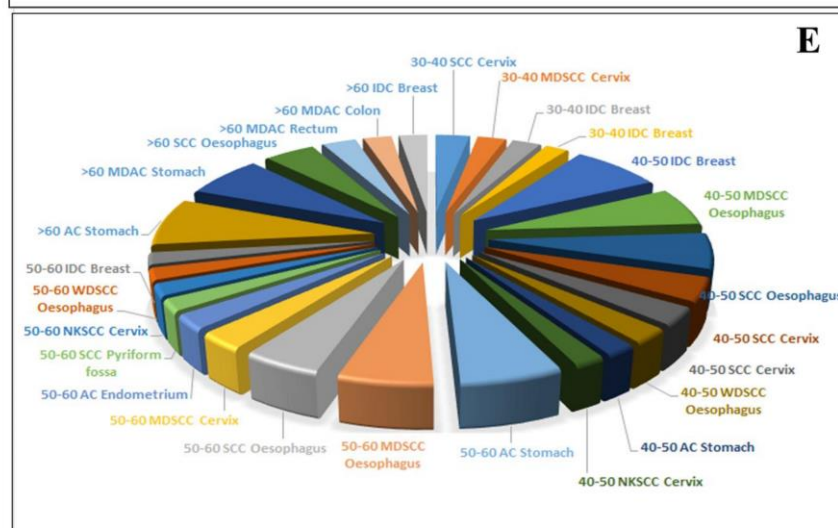
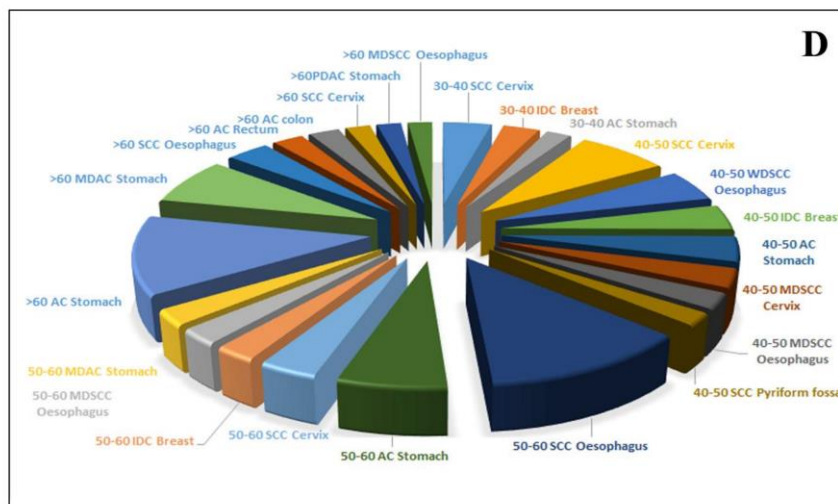
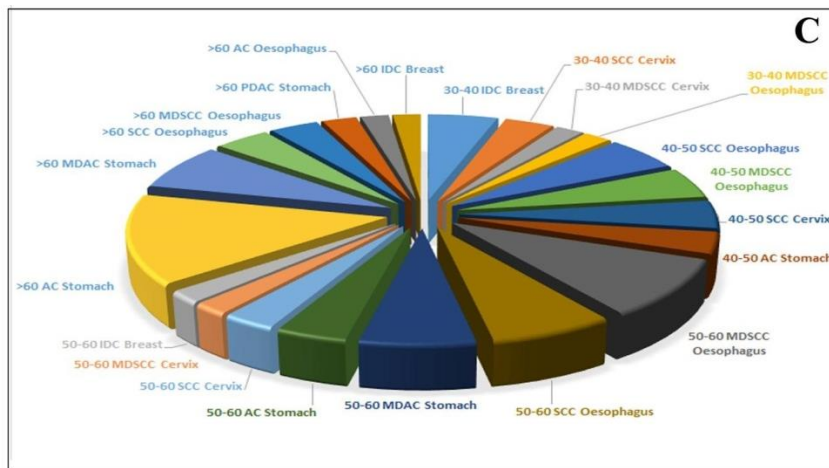


Figure 2. Frequency of cancer prevalence and status in Mizo population for the years 2011 (A), 2012 (B), 2013 (C), 2014 (D), 2015 (E).

AC – Adenocarcinoma; IDC – Invasive Duct Carcinoma; SCC – Squamous Cell Carcinoma; MDAC – Moderately Differentiated Adenocarcinoma; MDSCC – Moderately Differentiated Squamous Cell Carcinoma; PDAC – Poorly Differentiated Adenocarcinoma; WDSCC – Well Differentiated Squamous Cell Carcinoma; NKSCC – Non – Keratinising Squamous cell carcinoma.

## DISCUSSION

Our studies reveal that Cancer is diagnosed more in women than in men. It also shows an increase in occurrence of cancer with increase in age. Women are showing high rate of cancer because of the alarming increase in cervical and breast cancer for the last five years. Cervical cancer is caused by human papillomavirus infection. Human papillomavirus promotes uncontrolled cell division and accumulation of genetic damage. Other cancers attributed to human papillomavirus infection include those of vagina (70%), penis (50%), vulva (43%), and oropharynx (26%) (Table 1)[Hariri et al.,2011]. Breast cancer occurrence is highest after 35 years of age. The possible risk factor for occurrence of breast cancer was contributed by stress in the form of higher education and occupation, late menopause, history of induced abortion, first-degree family history of the disease and body mass index [Thapa et al.,2016]. The most common type in males is stomach cancer, followed by oesophageal. Tobacco smoking and use of smokeless tobacco, chewing tobacco and tuibur coupled with unhealthy food items such as smoked meat and vegetables and fermented soyabean and pork etc. may attribute to the high incidence of cancer in Mizoram [Ghatak et al.,2016].

The food habits of Mizoram are known to contribute to various different types of cancers. Smoke-drying and preservation leads to formation of N-nitroso compounds. Nitrite reacts with amines and amides found in meats and other proteins to form N-nitroso compounds, which are animal carcinogens and possible human carcinogens. Furthermore, although salt is not a carcinogen, it is thought to increase the risk of gastric cancer through direct damage to the gastric mucosa, which results in gastritis, increased DNA synthesis, and cell proliferation. This indirectly

contributes to the development of chronic atrophic gastritis, leading to the development of stomach cancer. Because of the presence of both salt and nitrite in processed fish and meats, its role in the development of stomach cancer cannot be ignored, as was found by Phukan et al. [Phukan et al.,2006]. Frequent consumption of sa-um was found to be associated with the risk of developing stomach cancer. This is a food material uniquely consumed in Mizoram. Dietary intakes of total or saturated fat have been shown to be associated with stomach cancer. Boiled pork fat, in addition to being a rich source of saturated fat, may form carcinogenic compounds during long storage, as in other stored meats. Use of soda was shown to be a risk factor. Indigenous people of the northeastern region of India use soda (alkali) or other alkaline preparations frequently as food additives.

The consumption of tobacco is the leading cause of cancers in India. The regular use of tobacco via smoking, chewing, snuffing etc. in Mizoram, which is responsible for 65 to 85% cancer incidences in men and women, respectively. The various cancers produced by the use of tobacco are of oral cavity, pharynx, esophagus, larynx, lungs and urinary bladder. Smoking is the most notorious factor for the causation of lung cancer [Hammond et al.,1966]. Approximately, 87 and 85% males and females have been found to have lung cancer due to tobacco smoking in the form of local Zozial (a thin South Asian cigarette type structure filled with tobacco flake and wrapped in a white paper, tied with a string at one end) [Behera et al.,2004] and cigarette in India [Jayant et al.,1991]. The severe carcinogenic nature of Asian local made cigarette has been proved by the studies of Jussawalla and Jain [Jussawalla et al.,1979] and [Pakhale et al.,1990]They observed that the unrefined form of tobacco used in bidis (WHO, 1999) and the

frequency with which a bidi needs to be puffed per minute may be responsible for its relatively higher carcinogenic effects as compared to cigarettes [Bano et al.,2009]. Bidi smoking at two puffs per minute produces about equal amounts of carcinogens (steam volatile phenols, hydrogen cyanide and benzopyrene) as produced by one puff per minute of unfiltered cigarette [Pakhale et al.,1990 ] Hookah (a special cigar used in Mizoram using raw tobacco) smoking causes lung cancer; as reported by Nafae et al. [Nafae et al.,1973] In Mizoram, North-eastern India high incidences of stomach cancer are attributed to the consumption of smoked meat and chewing of tobacco. High incidences of stomach cancer in Mizoram are the result of the excessive use of tuibur (water filtrate of tobacco).

Similarly, the consumption of Areca nut, Pan Masala, Opium and Bhang (leaves and flower powder of female cannabis plant) has been recognized as the major cause of mouth cancer in Mizoram. The daily consumption of the number betel leaves by an individual is about 15-25 in various districts of Mizoram, which continuously acts as an irritant to the buccal mucosa [Mehrotra et al.,2003]. One of the most important factors responsible for the oropharyngeal malignancy in Mizoram is the chewing of raw betel nut [Wahi et al.,1965]. Among various risk factors for the occurrence of oesophageal cancer in Mizoram, betel quid chewing carries a relative risk of 1.5 to 3.5%. The salted cooked vegetables made by adding sodium bicarbonate has shown to possess a high methylation activity and may lead to the endogenous formation of nitrosamine [Malkan et al.,1997] and that can lead to stomach cancer.

Alcohol consumption has been considered as one of the major causes of colorectal cancer as per a recent monograph of WHO [Baan et al.,2007]. Annually, about 9.4% new colorectal cancer cases are attributed to the consumption of alcohol, globally [Parkin et al.,2006]. An increased risk of 10% was observed with consumption of more than two drinks per day, which suggests a causative role

of alcohol consumption in colorectal cancer [Toriola et al.,2008]. Recently, a study revealed that an increased risk of colorectal cancer was limited to consumption of more than 30.0 g of alcohol per day [Longnecker et al.,1990]. Relationship between alcohol consumption and high risk of oesophageal cancer was first known in 1910 [Tuyns et al.,1979]. However, chronic alcohol consumption has been found to be a risk factor for the cancers of the upper respiratory and digestive tracts, including oral cavity, hypopharynx, larynx and oesophagus as well as liver, pancreas, mouth and breast cancers [Tuyns,1979;Maier,1994;Seitz et al.,2004]. A 10.0 g/day intake of alcohol by a woman increases its relative risk of breast cancer by 7.1% [Doll et al.,1981]. The mechanism of carcinogenesis due to alcohol consumption is not exactly known, however, it is thought that ethanol being a co-carcinogen might play a crucial role in the carcinogenesis [Poschl et al.,2004]. The metabolic products of ethanol are acetaldehyde and free radicals. The free radicals are responsible for alcohol assisted carcinogenesis through their binding to DNA and proteins, which destroy foliate leading to secondary hyper proliferation [Anand et al.,2008].

Non-tobacco risk factor includes infections, dietary factors, alcohol use, physical activities and body composition. Other risk factors include exposure to asbestos, air pollution (indoor and outdoor), occupational exposures and exposure to radiation. Consumption of alcohol is shown to be associated with cancers of the mouth, pharynx, larynx, oesophagus, colo-rectum (men) and breast (pre- and post- menopausal). Aflatoxins causes liver cancer. Arsenic in drinking water and beta-carotene supplements are known to contribute to lung cancer. Colo-rectum is known to be caused by excess consumption of red and processed meat in our diet. Associations between infections and cancer: HPV(Human Papilloma Virus) infection and cervical cancer, Epstein Barr Virus(EBV) and Burkitt Lymphoma as well as Non-Hodgkin and Hodgkin Lymphoma, Hepatitis-C virus and hepatocellular

carcinoma, Kaposi Sarcoma Herpes Virus (KSHV) and Kaposi Sarcoma [Harford et al.,2012].

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## Conflict of interest

The authors declare that no competing or conflict of interests exists. The funders had no role in study design, writing of the manuscript, or decision to publish.

## Authors' contributions

JZ and NSK conceptualized the study; MVT and FL collected the primary data; MVT, SG and FL did the analysis and interpretation of the data; MVT, SG, NSK and JZ wrote the manuscript.

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