RESEARCH ARTICLE

Correlation of Cancer Incidence with Diet, Smoking and Socio-Economic Position Across 22 Districts of Tehran in 2008

Marzieh Rohani-Rasaf[1], Morteza Abdollahi[2], Shima Jazayeri[3], Naser Kalantari[4], Mohsen Asadi-Lari[5]*

Abstract

Background: Variation in cancer incidence in geographical locations is due to different lifestyles and risk factors. Diet and socio-economic position (SEP) have been identified as important for the etiology of cancer but patterns are changing and inconsistent. The aim of this study was to investigate correlations of the incidence of common cancers with food groups, total energy, smoking, and SEP. Materials and Methods: In an ecological study, disaggregated cancer data through the National Cancer Registry in Iran (2008) and dietary intake, smoking habits and SEP obtained through a population based survey within the Urban Health Equity Assessment (Urban-HEART) project were correlated across 22 districts of Tehran. Results: Consumption of fruit, meat and dairy products adjusted for energy were positively correlated with bladder, colorectal, prostate and breast and total cancers in men and women, while these cancers were adversely correlated with bread and fat intake. Also prostate, breast, colorectal, bladder and ovarian cancers had a positive correlation with SEP; there was no correlation between SEP and skin cancer in both genders and stomach cancer in men. Conclusions: The incidence of cancer was higher in some regions of Tehran which appeared to be mainly determined by SEP rather than dietary intake. Further individual data are required to investigate reasons of cancer clustering.

Keywords: Cancer incidence - food groups - smoking - socio-economic position (SEP) - Tehran

Asian Pacific J Cancer Prev, **14 (3)**, 1669-1676

Introduction

Variation in incidence of cancer in different geographical locations is partly due to different risk factors that are associated with lifestyle (Parkin et al., 2009; de Vries et al., 2010). Many factors have been identified to be involved in the etiology of cancer such as tobacco, alcohol, occupation, air pollution, water contaminations, diet and nutrition, obesity, physical activity, infectious agents, and solar radiation, which are all probable factors (Schottenfeld and Fraumeni, 2006). Principal risk factors for cancer in western countries consist of smoking, dietary patterns, and reproductive behaviors and in developing countries is infectious agents, but these patterns are changing. For example smoking is increasing in some developing countries (Jemal et al., 2010).

Nutritional factors contribute about 35% of cancer cases (Doll and Peto, 1981). The lower incidence of total cancer in Mediterranean countries in comparison with Scandinavian countries, the United Kingdom, and the United States is mostly because of lower incidence cancer of the large bowel, breast, endometrium, and prostate that could be attributable to dietary factors across Mediterranean countries. If the Western people could switch to the Mediterranean diet, some cancers would be decreased (Trichopoulou et al., 2000). The increased colorectal cancer incidence rates in some countries in Asia, Eastern Europe and Spain are associated with changes in dietary and lifestyle factors (Garcia-Alvarez et al., 2007; de Kok et al., 2008; Martin et al., 2008; Center et al., 2009a; 2009b).

Many epidemiological studies have been conducted to investigate the role of dietary pattern and various cancers (Trichopoulou et al., 2000; Prentice et al., 2007; Ozasa et al., 2001; 2010; Riboli and Norat, 2001; Mohebbi et al., 2011). Meat and processed meat for colorectal malignancy, arsenic for lung and skin cancers, beta carotene supplements for lung cancer, and aflatoxin for liver cancer have been identified in various studies (2007). Convincing evidence support the decreasing effects of vegetables and fruits for mouth, pharynx, larynx, esophagus, stomach and lung cancers, while vegetable alone decrease the risk of colorectal cancer. Red and particularly processed meat increase the risk of colorectal cancer, and processed meat

*[1]Department of Epidemiology and Biostatistics, [3]Nutrition, School of Public Health, [5]Department of Epidemiology and Biostatistics, School of Public Health, and Oncopathology Research Centre, Tehran University of Medical Sciences, [2]Department of Nutrition Research, [4]Department of Community Nutrition, National Nutrition and Food Technology Research Institute, Faculty of Nutrition Sciences and Food Technology, Shaheed Beheshti University of Medical Sciences, Tehran, Iran *For correspondence: asadilari@tums.ac.ir*

and salt are probable risk factor for stomach cancer (Riboli and Norat, 2001). In a systematic review more studies found no significant relationship between vegetable and fruit intake separately and colorectal cancer risk but the combined consumption of vegetables and fruits reduced the risk in half of the studies. Marques-Vidal reported that relationship between dietary intake and colorectal cancer might be less important than previously reported (Marques-Vidal et al., 2006). There are case control studies suggesting the relation between high consumption of fiber and decreased risk of breast cancer, (Baghurst and Rohan, 1994; La Vecchia et al., 1997) however these finding are not confirmed in longitudinal studies (Verhoeven et al., 1997; Willett et al., 1992).

Review articles point out to conflicting epidemiological studies, which in one hand do not support the overall well known hypotheses such as lack of protective effect of a high fruit- vegetable diet and on the other hand, emphasizing the hazardous effect of fat- intakes in breast cancer (Key et al., 2003; Hanf and Gonder, 2005). A meta-analysis on the association between breast cancer risk and red meat consumption in premenopausal women reflected a summary relative risk as 1.24 (95%CI 1.08-1.42) (Taylor et al., 2009).

Various studies have indicated that incidence of cancer varies across socio-economic position (SEP) groups and health disparities exist between and within countries even within cities (Yiengprugsawan et al., 2007; IAEA, 2011). Social, economical, environmental and political factors have been apparently known as the stem of inequalities in health. Equality of breast cancer incidence in high risk immigrants with the destination society suggests that environmental rather than genetic risk factors play a role of causality (Kelsey and Horn-Ross, 1993; Wu et al., 1996). Understanding the role of socioeconomic determinant of health (SDH) helps implement appropriate interventions to reduce disparities. Socioeconomic characteristics such as income, wealth, education, occupation, social class, and insurance coverage are potential indicators for comparison of different groups based on health and social features (Braveman et al., 2001; Yiengprugsawan et al., 2007; Natale-Pereira et al., 2011). The proportion of cancer incidence across SEP is dissimilar by cancer types; while some cancers are more common in higher socio-economic positions such as prostate and breast cancers, a variety of cancers prevail in lower SEP groups such as lung and cervical cancers (Yin et al., 2010). Investigation of correlation between SEP and cancer incidence may result in detection of disparities in cancer and particularly socio-economic groups with high burden of cancer. The aim of this study is to investigate correlation of common cancers with dietary groups, total energy, smoking, and SEP.

Materials and Methods

In this ecological study various sources of information were included population data for all 22 districts of Tehran which was obtained from 2006 census of Iran Statistical Center, cancer data from National Cancer Registry in 2008, (Rohani et al., 2011) and dietary pattern from Urban HEART-1 study (Asadi-Lari et al., 2010). Home addresses and phones were extracted from cancer registry database and cancer patients' districts of residence were identified. Age standardized rates (ASR) per 100,000 men and women of Tehran were calculated using the direct method of standardization to new (2000) WHO World Standards (Ahmad et al., 2009). ASR for common cancer types including prostate, colorectal, stomach, skin and bladder cancer in men and breast, colorectal, skin, stomach and ovarian cancer in women were estimated across 22 districts.

Dietary intake, smoking habits and SEP were obtained through Urban Health Equity Assessment and Response Tool (Urban-HEART) project which was conducted in 2008, (Asadi-Lari et al., 2010) where almost 960 households in each 22 districts of Tehran and overall 21,120 households were approached. A smaller sample including 10% of Urban-HEART sample size was investigated for food consumption. A 24-hour food recall questionnaire which referred to the household food consumption during the preceded 24-hour, was completed through a detailed interview usually with the housewife. A specific software was used to transform the food stuff into nutrition categories and energy intake, then the distribution of food groups consumption (mean g/day) across 22 districts were determined. Food groups consisted of bread, grain, vegetable, fruit, meat, egg, dairy products, fat, pastries, drinks and nuts (Asadi-Lari et al., 2010).

To produce SEP groups, a proxy value was calculated for all individuals using principal components analysis (PCA); then a median score for each district was used. Assets and house features consisting of house ownership, room per person, area per capita, having independent bath, kitchen, toilet, owning car, landline, cell phone, freezer, and computer for the household, and the years of education were calculated for individuals over 6 years old (Rohani-Rasaf et al., 2012). Districts were accordingly sorted by these values then categorized into four classes based on population of districts to make a similar population in each class.

We investigated correlation between cancer incidence and food groups, SEP scores and smoking using Pearson correlation; partial correlation was used for better interpretation in smoking levels. To examine the contribution of SEP in common cancers, R square was calculated using regression model. A p-value less than 0.05 was considered as significant.

Results

Although no large variation of the mean of consumption exists between districts we observed lower consumption of bread, fats and vegetables and higher consumption of meat, dairy products and fruit in districts with higher SEP (Table 1).

Districts with less-advantaged socioeconomic groups (1) to more-advantaged (4) are listed in Table 1. While smoking in men was positively correlated with SEP ($r=0.69$ $p<0.01$), which indicates that smoking rate was higher in affluent than less-advantaged districts, smoking in women had reverse correlation with SEP (r=-0.6

Table 1. Distribution of Probable Risk Factors in 22 Districts of Tehran (consumption of food groups mean g/ day, smoking) and Median Score of SEP

	Bread	Grain	Vegetable	Fruit	Meat	Egg	Dairy	Fat	sugar	Nuts	Drinks	SEP groups	% Male Smoking Rate
Districts													
1	277	43	292	360	134	45	283	29	66	20	47	4	14.40%
2	267	45	322	416	110	40	352	32	71	23	44	4	15.20%
3	246	42	298	467	136	63	361	36	83	23	55	4	12.90%
4	324	46	327	426	111	54	329	35	86	21	46	3	14.00%
5	330	54	261	417	112	35	304	35	70	17	56	4	15.70%
6	286	46	327	518	126	55	378	30	84	20	44	4	15.60%
7	298	52	315	372	117	52	327	40	78	29	20	3	19.90%
8	320	52	314	397	97	55	270	36	66	22	31	3	16.90%
9	350	52	379	441	93	52	296	48	88	23	34	2	18.30%
10	348	66	330	337	121	58	261	54	83	29	67	2	20.60%
11	337	47	306	308	97	44	304	38	97	27	45	2	19.70%
12	332	44	305	385	121	57	286	47	73	31	20	2	15.40%
13	330	46	235	350	98	49	295	38	74	18	20	2	15.70%
14	341	49	250	347	89	46	325	45	56	26	37	2	14.70%
15	341	55	366	386	98	55	262	54	90	22	55	1	18.40%
16	369	53	265	280	106	57	253	42	78	17	56	1	17.80%
17	391	65	303	347	96	54	256	45	65	30	29	1	18.60%
18	389	72	293	363	108	54	227	43	81	25	27	1	16.40%
19	386	54	296	393	107	56	315	49	87	20	41	1	17.70%
20	380	44	301	344	111	45	236	43	68	17	22	1	15.90%
21	390	48	317	301	115	48	287	35	73	25	32	2	16.40%
22	355	52	315	441	136	45	332	41	76	28	37	3	14.70%
R pearson-0.81** (correlation with SEP)		-0.59**	-0.05	0.53*	0.61**	-0.29	0.69**	-0.8**	-0.14	-0.15	0.16		0.69**

*at 0.05 (2 tailed). **is significant at 0.01 level (2 tailed)

Table 2. Common Cancer ASRs Across 22 Districts of Tehran and Their Correlation with SEP and Smoking

	Common cancer ASRs in men					Common cancer ASRs in women				
	Prostate	Colorectal	Stomach	Skin	Bladder	Breast	Colorectal	Skin	Stomach	Ovary
Districts in Tehran										
1	32.690	22.490	15.962	16.503	19.856	60.080	17.374	6.868	10.835	8.791
2	32.180	19.538	14.719	15.645	13.048	51.890	15.611	9.556	6.649	4.231
3	30.900	31.668	12.551	14.322	21.364	73.885	16.450	8.147	11.986	9.671
4	12.220	14.205	14.884	9.364	12.865	36.636	18.453	6.879	6.455	4.875
5	23.810	22.363	15.282	13.457	9.797	47.133	12.075	11.472	9.535	6.516
6	42.820	28.998	17.202	18.827	14.825	49.071	21.186	7.871	7.309	11.499
7	29.750	19.086	10.648	11.838	17.483	46.292	9.694	8.481	5.615	4.949
8	14.740	10.632	13.503	8.564	13.133	37.585	12.109	5.549	4.027	1.503
9	11.330	6.254	13.123	9.452	4.433	20.598	3.962	8.378	7.590	0.846
10	14.280	13.939	9.835	13.648	8.248	26.513	10.271	10.959	6.696	5.865
11	13.430	15.210	12.972	15.229	9.422	45.782	10.062	7.575	6.564	6.279
12	9.900	15.107	13.458	5.197	11.193	28.653	6.710	11.196	0.978	5.230
13	19.720	14.141	15.561	9.074	15.434	30.843	8.904	11.732	4.457	1.470
14	13.310	10.177	7.964	8.298	3.620	26.880	11.790	7.273	6.031	3.506
15	7.590	6.500	10.209	7.783	4.247	16.042	9.045	6.603	7.778	2.256
16	9.225	8.450	13.453	16.339	12.375	21.798	5.708	6.429	6.270	3.229
17	4.902	14.069	7.367	3.096	8.178	14.427	5.866	1.083	5.349	2.835
18	10.130	6.653	23.741	12.771	1.288	12.106	7.684	8.112	4.655	0.781
19	2.989	17.917	24.759	3.689	4.611	14.996	4.851	5.024	3.631	1.716
20	6.516	6.034	13.861	23.718	7.427	23.107	9.390	12.850	8.953	4.556
21	20.220	8.236	5.601	13.533	5.820	21.845	3.157	4.500	4.500	10.916
22	7.516	13.681	19.579	12.176	22.735	12.403	6.551	10.165	18.276	0.000
Total	19.500	16.400	13.900	12.400	11.500	38.000	12.200	8.500	7.100	5.100
Correlation with										
SEP1	0.830**	0.710**	0.040	0.400	0.720**	0.820**	0.690**	0.260	0.440*	0.570**
Smoking	0.852**	0.770**	0.810	0.320	0.560**	-0.360	-0.480*	-0.190	-0.340	-0.230

*at 0.05 (2 tailed). **is significant at 0.01 level (2 tailed)

p<0.01). All common cancers in men and women were positively correlated with SEP, which means that cancer incidence increased with departure from less-advantaged to affluent districts except skin and stomach in both genders which showed no significant correlation with SEP. Stomach cancer in men was higher in more disadvantaged districts in southern Tehran. Higher incidence of breast and colorectal cancers in both sexes were observed in the highest SEP group. Also prostate, colorectal and bladder cancers in men were positively correlated with smoking

rate indicating that higher incidence of cancers prevailed in districts with higher rates of smoking and colorectal cancer in women had reverse correlation with smoking rate at district level. In regression analysis, the standardized coefficient for prostate and breast cancers as depended variables and SEP as predictor were 0.83 and 0.81 respectively. B for colorectal cancers in men and women were 0.71 and 0.69 while stomach cancer in women had a moderate correlation with SEP. No correlation was found between skin cancer in both genders and stomach cancer in men with SEP (Table 3).

Fruit, meat and dairy products adjusted by energy were positively correlated with bladder, colorectal, prostate and breast and total cancers in men and women, while these cancers were adversely correlated with bread and fat consumption. Meat consumption was positively correlated with stomach cancer in women and with skin cancer in men (Table 4). After adjustment for SEP, only bladder cancer was correlated with meat (r=0.47) and colorectal cancer with dairy (r=0.5) in men also colorectal cancer was negatively correlated with bread in both sexes.

Table 3. Regression Results for Cancers as Dependent Variables and SEP as Predictor

Common cancers	Adj. R^2	B	F	P
Men cancers				
Prostate	0.67	0.83	44.30	0
Colorectal	0.48	0.71	20.70	0
Skin	0.12	0.40	3.93	0.06
stomach	-0.04	0.44	0.04	0.84
Bladder	0.49	0.71	21.30	0
Women cancers				
Breast	0.65	0.82	40.70	0
Colorectal	0.45	0.69	18.50	0
Stomach	0.15	0.43	4.77	0.04
skin	0.02	0.26	1.50	0.23
Ovary	0.29	0.56	9.44	0.006

Discussion

This study showed the distribution of common cancers and their ecological correlation with smoking, food groups and SEP across 22 districts of Tehran in 2008. Food groups and cancers had strong correlation with SEP in Tehran. Breast, prostate, colorectal and ovary cancers clearly were high in affluent districts. It has shown that lower consumption of breads, fats and vegetable and higher consumption of meat, dairy products and fruit and higher smoking significantly was seen in affluent districts.

WHO estimates that common cancer incidence (39 per 100,000 women) and the second leading cause of cancer-related deaths (12.5) was related to breast cancer among women in world in 2008 (GLOBOCAN IARC, 2010) There are an increasing trend in breast cancer (BC) incidence in Iran over the past two decades; according to a population based cancer registry in 5 provinces during 1996-2000 the incidence rate was 16.2 per 100,000 population (Sadjadi et al., 2009) while BC incidence in Tehran was 22.4 in 1998, (Harirchi et al., 2005) 31.4

Table 4. Correlation between Food Groups and Incidence of Common Cancers in Tehran

Cancer	Food groups adjusted for smoking				Food groups adjusted for energy			
	Positive	r	Negative	r	Positive	r	Negative	r
Bladder	Meat	0.58	Bread	0.44	Fruit	0.49	Bread	0.64
					Meat	0.76	Fat	0.50
					Dairy Products	0.59		
Colorectal	Fruit	0.45	Vegetable	0.52	Fruit	0.69	Bread	0.77
	Meat	0.45			Meat	0.71	Fat	0.50
	Dairy Products	0.48			Dairy Products	0.78		
Skin					Meat	0.47	Fat	0.43
Prostate			Vegetable	0.45	Fruit	0.65	Bread	0.68
			Fat	0.57	Meat	0.69	Fat	0.62
			Suger	0.58	Dairy Products	0.79		
Total Cancer In Men	Meat	0.60	Bread	0.66	Fruit	0.69	Bread	0.71
	Dairy Products	0.50	Fat	0.65	Meat	0.81	Fat	0.71
			Vegetable	0.49	Dairy P Products	0.77		
			Egg	0.49				
Breast	Dairy Products	0.50	Bread	0.88	Fruit	0.61	Bread	0.76
			Fat	0.62	Meat	0.69	Fat	0.53
			Grain	0.48	Dairy Products	0.78		
Colorectal	Drink	0.50	Bread	0.74	Fruit	0.7	Bread	0.72
	Dairy Products	0.43	Fat	0.48	Meat	0.55	Fat	0.53
					Dairy Products	0.68		
					Drink	0.43		
Stomach	Meat	0.46			Meat	0.46		
Ovary	Meat	0.47	Fat	0.49	Meat	0.62	Fat	0.48
					Dairy Products	0.48		
Total Cancer In Women	Meat	0.60	Bread	0.66	Fruit	0.69	Bread	0.71
	Dairy Products	0.50	Fat	0.65	Meat	0.81	Fat	0.71
			Vegetable	0.49	Dairy P Products	0.77		
			Egg	0.49				

during the period of 1998-2001 (Mohagheghi et al., 2009), and 36 in 2008 (current study). Studies inconsistently suggest that fruits and vegetables, low-fat dairy products, fish, monounsaturated and polyunsaturated fatty acids, may reduce the risk of breast cancer, whilst, high intake of meat, poultry, total energy, total fat and saturated fatty acids probably increase the risk (Koo et al., 1997; Holmes et al., 2003; Key et al., 2007; Bissonauth et al., 2008). In this study breast cancer was significantly and positively correlated with meat, dairy and fruit consumption and inversely correlated with bread after adjusting for SEP. In the Netherland cancer incidence low SEP groups were replaced by high SEP groups for increased prostate, breast cancers and BCC so that had notably trend during 1996-2008 (Aarts et al., 2010).

A systematic review on cancer incidence across different SEP groups in 21 countries showed that higher risk of breast cancer in women was seen with high SEP (Faggiano et al., 1997) and women with lower education level had lower risk of breast cancer, (Spadea et al., 2009) both of which are consistent with our findings, where breast cancer was more seen in affluent districts in higher SEP groups (R=0.82) and have the most strong B between women cancers.

Second common cancer incidence in men is prostate cancer (GLOBOCAN IARC, 2010). Incidence of prostate cancer in this study was higher than estimation of WHO for Iran in 2008 (19.5 per 100,000 v.s 11.6). Many risk factors such as aging, race, family history, gonadal steroids and Insulin-like growth factor I (IGF-I), processed red meat, dairy products and fat (as provoking factors) (Koo et al., 1997; Ngo et al., 2003; Tseng et al., 2004; Schottenfeld and Fraumeni, 2006; Grant, 2010) and cereals, nuts, oilseeds, fish, (Hebert et al., 1998) vitamin E (Schottenfeld and Fraumeni, 2006) soy products (Hebert et al., 1998) and cholesterol (Hu et al., 2012) (as protective factors) have been identified for prostate cancer; in our study dairy products and meat correlated positively and bread and fat negatively with prostate cancer. In a prospective study, prostate cancer was not associated with the vegetable-fruit or red meat-starch pattern, but higher intake of the Southern pattern characterized by cornbread, grits, sweet potatoes, okra, beans, and rice showed a significant reduced risk (Tseng et al., 2004). On the other hand, in districts with low education level, prostate cancer was less common, which is in line with other studies (Steenland et al., 2004; Spadea et al., 2009) and might be due to more PSA tests, early detection or more access to healthcare services.

Colorectal cancer (CRC) was estimated at global level in 2008 to be the second and third common cancer in women and men respectively (GLOBOCAN IARC, 2010). CRC incidence in men (16.4) and women (12.2) were higher than WHO estimation for Iran, while CRC incidence for Tehrani men was higher than neighboring countries such as Pakistan and Turkey (IAEA, February 2011, Jemal et al., 2011). Trichopoulou proposed that approximately up to 25% of the incidence of CRC, could be prevented if the population diet could transfer to the Mediterranean diet (Trichopoulou et al., 2000). The combined consumption of vegetables and fruit, high intake of fiber, fish, unsaturated fat, vitamins and calcium decrease the risk and high consumption of red or processed meat, smoked or salted fish actually appears to be harmful, which increase CRC risk (Jacobs et al., 2003; Marques-Vidal et al., 2006; Bravi et al., 2010; Gonzalez and Riboli, 2010; Randi et al., 2010; Chan et al., 2011). Our results indicate that CRC was correlated with meat, dairy products and fruits adjusted for total energy and reverse correlation with bread and fat. CRC was more common in higher SEP groups in 21 countries in 1997, (Faggiano et al., 1997) which was consistent with our findings with a correlation coefficient of 0.69-0.71. Higher CRC incidence among high SEP group recommended a higher prevalence of risk factor such as smoking in this group in Tehran but in 2012 the overall incidence of CRC after controlling for other risk factors was significantly higher among low educational level or low-SEP groups where prevalence of adverse health behaviors along with BMI explained 36% of the association of local SEP with risk of colorectal cancer (Doubeni et al., 2012a; 2012b). Evidence indicates a upward slope between CRC incidence and socioeconomic deprivation in recent decade which SEP pattern in CRC has changed direction (Kee et al., 1996; Faggiano et al., 1997; Pollock and Vickers, 1997; Oliphant et al., 2011).

Skin cancer is the most common cancers in Iran, notably that basal cell carcinoma (BCC) was more frequent in the current study. It is suggested that fat intake, residence in high solar radiation and sun exposure are associated with an increased risk of BCC (van Dam et al., 1999) while monounsaturated fat consumption is associated with a lower risk (van Dam et al., 2000). In a prospective study, high meat and fat intake increased SCC particularly in patients with a family history, (Ibiebele et al., 2007) which was in line with our findings only in men. In a multinational study across 21 countries excessive risk of melanoma was observed in higher SEP, (Faggiano et al., 1997) and in another study this association was attributed to education, (Harrison et al., 1998) contrary to our findings which indicated prevailed skin cancer in district 20 with lower SEP.

Stomach cancer incidence in Iranian men was estimated higher than the world statistics in 2008 (GLOBOCAN IARC, 2010), while our findings depict a lower incidence than WHO estimates, regarding the fact that our data are based on pathology reports which may underestimate the highly fatal stomach cancer (Zendehdel et al., 2010). Various risk factors have been recognized such as helicobacter pylori (H pylori) infection, cured meat, smoking, and alcohol while Mediterranean diet, vegetables and fruits, vitamin C, retinol and high intake of cereal fiber decrease the risk of stomach cancer (Kolonel et al., 1981; Demirer et al., 1990; Schottenfeld and Fraumeni, 2006; Wang, 2009; Gonzalez and Riboli, 2010). An ecologic analysis in Brazil suggested that differences in living standards among populations probably have an important role in incidence differences (Koifman and Koifman, 1997). The high level of education in men and higher SEP were associated with lower stomach cancer risk and for education exist even after age adjustment (RR highest to lowest level=0.54) which was diluted

by variables such as smoking, intake of vitamin C, beta carotene, alcohol, coffee and family history of stomach cancer (Faggiano et al., 1997; van Loon et al., 1998). Our results showed that stomach cancer only in women was correlated with meat and correlation of stomach cancer and SEP in both sexes was inconsistent so that higher incidence in men was in low SEP districts, while in women it prevailed in high SEP districts.

Ovarian cancer incidence in Iran is lower than similar world statistics and much lower than USA in all age groups, (Arab et al., 2010; GLOBOCAN IARC, 2010) but it is one of the most common cancers in women in Tehran. Consumption of eggs, lactose intake and dairy foods increase the risk of ovarian cancer and inconsistent studies suggested that fruits and vegetables intake and plant-based diet may decrease the risk (Kushi et al., 1999; McCann et al., 2003; Larsson et al., 2006). In the current study there was a positive correlation between meat and dairy products and ovarian cancer and a reverse correlation with fat intake. SEP explained 32% of ovarian cancer, which justifies a positive and strong inference, likewise other studies in the literature which propose higher SEP as a predictor of ovarian cancer (Faggiano et al., 1997; Liu et al., 1998).

Bladder cancer incidence in Iranian men (11.2) has been estimated higher than the similar figures in Eastern Mediterranean Region and the global incidence. (GLOBOCAN IARC, 2010) Studies suggest that pork, barbecued meats, fat, butter, soy, eggs and excessive coffee consumption are associated with increased risk (Radosavljevic et al., 2005; Keszei et al., 2010; Silberstein and Parsons, 2010) and vegetables, fruits, and cereal are associated with decreased risk of bladder cancer. Bladder cancer incidence is correlated with SEP (Buntinx et al., 2003), while when adjusted for smoking the relative risk of bladder cancer has been decreased (Goy et al., 2008). This study, nevertheless showed that consuming meat, dairy products, and fruit and SEP were related to high incidence of bladder cancer while districts with higher intake of bread and fat were correlated with reduced bladder cancer.

Various limitations existed in this study; first ecologic fallacy was the main obstacle which may bias the inferences and any generalized conclusion should be therefore avoided. As explained in the method, two sources of data were compared in this study, one came from a large population based household survey, which sought for inequalities in social determinants of health (Urban HEART) (Asadi-Lari et al., 2010) and one arose from mandatory cancer registry. Amalgamating these two sets of information may deviate the inferences due to the fact that there is no evidence of dietary pattern of cancer patients. Second, diet has a long term effect on cancer which has been estimated between 5-20 years; (Colditz et al., 2012) therefore correlating two sets of data at the same year may also deviate the conclusions. Our main assumption, for this inference, was unremarkable changes in dietary pattern at least in short-term, which is the least incubation period for cancer. Third, using a single 24-hour-recall may inherently jeopardize the inferences, however is not an problem if the goal is to estimate a mean intake for a population this method will introduce no bias (Rothman et al., 2008). Fourth, cancer registry in Tehran is based on pathology reports, which inherently faces with criticisms that stigmatize the data as incomprehensive and incomplete particularly for stomach cancer with high fatality rate, although the national coverage of cancer registry is estimated at 81% in 2008 (Rohani et al., 2011).

In conclusion, there is a wide range of age standard cancer incidence in 22 districts of Tehran which is correlated to SEP and diet. Socioeconomic patterns in incidence varied for specific cancers. Higher SEP was associated with higher rates of breast, CRC, prostate, bladder and ovarian cancers. There was lower consumption of bread, fat and vegetables and higher consumption of meat, dairy products and fruit in affluent districts. Consumption of fruit, meat and dairy products adjusted by energy were positively correlated with bladder, colorectal, prostate and breast, while these cancers were adversely correlated with bread and fat intake. However, majority of associations with food groups disappeared after adjustment for SEP. Whether what trait in SEP groups leads to clustering warrants further research to include individual data.

References

Aarts MJ, vanderAa MA, Coebergh JWW, Louwman WJ (2010). Reduction of socioeconomic inequality in cancer incidence in the South of the Netherlands during 1996-2008. *Eur J Cancer*, **46**, 2633-46.

Ahmad OB, Boschi-Pinto C, Lopez AD, et al (2009). Age standardization of rates: a new WHO standard. In. Geneva World Health Organization.

Arab M, Khayamzadeh M, Tehranian A, et al (2010). Incidence rate of ovarian cancer in Iran in comparison with developed countries. *Indian J Cancer*, **47**, 322-7.

Asadi-Lari M, Vaez-Mahdavi MR, Faghihzadeh S, et al (2010). The Application of Urban Health Equity Assessment and Response Tool (Urban HEART) in Tehran; concepts and framework. *Med J Islamic Republic of Iran*, **24**, 175-85.

Baghurst PA, Rohan TE (1994). High-fiber diets and reduced risk of breast cancer. *Int J Cancer*, **56**, 173-6.

Bissonauth V, Shatenstein B, Ghadirian P (2008). Nutrition and breast cancer among sporadic cases and gene mutation carriers: an overview. *Cancer Detection and Prev*, **32**, 52-64.

Braveman P, Starfield B, Geiger HJ (2001). World health report 2000: how it removes equity from the agenda for public health monitoring and policy. *BMJ*, **323**, 678-81.

Bravi F, Edefonti V, Bosetti C, et al (2010). Nutrient dietary patterns and the risk of colorectal cancer: a case-control study from Italy. *Cancer Causes Control*, **21**,1911-8.

Buntinx F, Geys H, Lousbergh D, et al (2003). Geographical differences in cancer incidence in the Belgian province of Limburg. *Eur J Cancer*, **39**, 2058-72.

Center MM, Jemal A, Smith RA, Ward E (2009a). Worldwide variations in colorectal cancer. *CA Cancer J Clin*, **59**, 366-78.

Center MM, Jemal A, Ward E (2009b). International trends in colorectal cancer incidence rates. *Cancer Epidemiol Biomarkers Prev*, **18**, 1688-94.

Chan D S, Lau R, Aune D, et al (2011). Red and processed meat and colorectal cancer incidence: meta-analysis of prospective studies. *PLoS One*, **6**, 20456.

Colditz GA, Wolin KY, Gehlert S (2012). Applying what we know to accelerate cancer prevention. *Sci Transl Med*, **4**, 127-4.

de Kok IM, Wong CS, Chia KS, et al (2008). Gender differences in the trend of colorectal cancer incidence in Singapore, 1968-2002. *Int J Colorectal Dis*, **23**, 461-7.

de Vries E, Soerjomataram I, Lemmens VE, et al (2010). Lifestyle changes and reduction of colon cancer incidence in Europe: a scenario study of physical activity promotion and weight reduction. *Eur J Cancer*, **46**, 2605-16.

Demirer T, Icli F, Uzunalimoglu O, Kucuk O (1990). Diet and stomach cancer incidence. A case-control study in Turkey. *Cancer*, **65**, 2344-8.

Doll R, Peto R (1981). The causes of cancer: quantitative estimates of avoidable risks of cancer in the United States today. *J Natl Cancer Inst*, **66**, 1191-308.

Doubeni CA, Laiyemo AO, Major JM, et al (2012a). Socioeconomic status and the risk of colorectal cancer: an analysis of more than a half million adults in the National Institutes of Health-AARP Diet and Health Study. *Cancer*, **118**, 3636-44.

Doubeni CA, Major JM, Laiyemo AO, et al (2012b). Contribution of behavioral risk factors and obesity to socioeconomic differences in colorectal cancer incidence. *J Natl Cancer Inst*, **104**, 1353-62.

Faggiano F, Partanen T, Kogevinas M, Boffetta P (1997). Socioeconomic differences in cancer incidence and mortality. *IARC Sci Publ*, **65**, 176.

Faggiano F, Partanen T, Kogevinas M, Boffetta P (1997). Socioeconomic differences in cancer incidence and mortality In: Pearce N, Susser M, Boffetta P, editors. Social inequalities and cancer. Lyon: IARC Scientific Publications. p 65-176.

Garcia-Alvarez A, Serra-Majem L, Ribas-Barba L, et al (2007). Obesity and overweight trends in Catalonia, Spain (1992-2003): gender and socio-economic determinants. *Public Health Nutr*, **10**, 1368-78.

GLOBOCAN IARC (2010). Cancer Incidence and Mortality Worldwide in 2008. In. Lyon: International Agency for Research on Cancer, WHO.

Gonzalez CA, Riboli E (2010). Diet and cancer prevention: Contributions from the European prospective Investigation into Cancer and Nutrition (EPIC) study. *Eur J Cancer*, **46**, 2555-62.

Goy J, Rosenberg MW, King WD (2008). Health risk behaviors: examining social inequalities in bladder and colorectal cancers. *Ann Epidemiol*, **18**, 156-62.

Grant WB (2010). A multicountry ecological study of risk-modifying factors for prostate cancer: apolipoprotein E epsilon4 as a risk factor and cereals as a risk reduction factor. *Anticancer Res*, **30**, 189-99.

Hanf V, Gonder U (2005). Nutrition and primary prevention of breast cancer: foods, nutrients and breast cancer risk. European *J Obstetrics & Gynecology and Reproductive Biology*, **123**, 139-49.

Harirchi I, Ghaemmaghami F, Karbakhsh M, Moghimi R, Mazaherie H (2005). Patient delay in women presenting with advanced breast cancer: an Iranian study. *Public Health*, **119**, 885-91.

Harrison RA, Haque AU, Roseman JM, Soong SJ (1998). Socioeconomic characteristics and melanoma incidence. *Ann Epidemiol*, **8**, 327-33.

Hebert JR, Hurley TG, Olendzki BC, et al (1998). Nutritional and socioeconomic factors in relation to prostate cancer mortality: a cross-national study. *J Natl Cancer Inst*, **90**, 1637-47.

Holmes MD, Colditz GA, Hunter DJ, et al (2003). Meat, fish and egg intake and risk of breast cancer. *Int J Cancer*, **104**, 221-7.

Hu J, La Vecchia C, de Groh M, et al (2012). Dietary cholesterol intake and cancer. *Ann Oncol*, **23**, 491-500.

IAEA (2011). Inequity in Cancer Care: A Global Perspective. In: IAEA HUMAN HEALTH REPORTS. Vienna, Austria: International Atomic Energy Agency. p 51.

Ibiebele TI, van der Pols JC, Hughes MC, et al (2007). Dietary pattern in association with squamous cell carcinoma of the skin: a prospective study. *Am J Clin Nutr*, **85**, 1401-8.

Jacobs EJ, Connell CJ, Chao A, et al (2003). Multivitamin use and colorectal cancer incidence in a US cohort: does timing matter? *Am J Epidemiol*, **158**, 621-8.

Jemal A, Bray F, Center MM, et al (2011). Global cancer statistics. *CA Cancer J Clin*, **61**, 69-90.

Jemal A, Center MM, DeSantis C, Ward EM (2010). Global patterns of cancer incidence and mortality rates and trends. *Cancer Epidemiol Biomarkers Prev*, **19**, 1893-907.

Kee F, Wilson R, Currie S, et al (1996). Socioeconomic circumstances and the risk of bowel cancer in Northern Ireland. *J Epidemiol Community Health*, **50**, 640-4.

Kelsey JL, Horn-Ross PL (1993). Breast cancer: magnitude of the problem and descriptive epidemiology. *Epidemiol Rev*, **15**, 7-16.

Keszei AP, Schouten LJ, Goldbohm RA, van den Brandt PA (2010). Dairy intake and the risk of bladder cancer in the Netherlands cohort study on diet and cancer. *Am J Epidemiol*, **171**, 436-46.

Key TJ, Allen NE, Spencer EA, Travis RC (2003). Nutrition and breast cancer. *The Breast*, **12**, 412-6.

Key TJ, Schatzkin A, Willett WC et al (2007). Diet, nutrition and the prevention of cancer. *Public Health Nutr*, **7**, 187-200.

Koifman S, Koifman RJ (1997). Stomach cancer incidence in Brazil: an ecologic study with selected risk factors. *Cad Saude Publica*, **13**, 85-92.

Kolonel LN, Nomura AM, Hirohata T, Hankin JH, Hinds MW (1981). Association of diet and place of birth with stomach cancer incidence in Hawaii Japanese and Caucasians. *Am J Clin Nutr*, **34**, 2478-85.

Koo LC, Mang OW, Ho JH (1997). An ecological study of trends in cancer incidence and dietary changes in Hong Kong. *Nutr Cancer*, **28**, 289-301.

Kushi LH, Mink PJ, Folsom AR, et al (1999). Prospective study of diet and ovarian cancer. *Am J Epidemiol*, **149**, 21-31.

La Vecchia C, Ferraroni M, Franceschi S, et al (1997). Fibers and breast cancer risk. *Nutr Cancer*, **28**, 264-9.

Larsson SC, Orsini N, Wolk A (2006). Milk, milk products and lactose intake and ovarian cancer risk: a meta-analysis of epidemiological studies. *Int J Cancer*, **118**, 431-41.

Liu L, Deapen D, Bernstein L (1998). Socioeconomic status and cancers of the female breast and reproductive organs: a comparison across racial/ethnic populations in Los Angeles County, California (United States). *Cancer Causes Control*, **9**, 369-80.

Marques-Vidal P, Ravasco P, Ermelinda CM (2006). Foodstuffs and colorectal cancer risk: a review. *Clin Nutr*, **25**, 14-36.

Martin JJ, Hernandez LS, Gonzalez MG, et al (2008). Trends in childhood and adolescent obesity prevalence in Oviedo (Asturias, Spain) 1992-2006. *Acta Paediatr*, **97**, 955-8.

McCann SE, Freudenheim JL, Marshall JR, Graham S (2003). Risk of human ovarian cancer is related to dietary intake of selected nutrients, phytochemicals and food groups. *J Nutr*, **133**, 1937-42.

Mohagheghi MA, Mosavi-Jarrahi A, Malekzadeh R, Parkin M (2009). Cancer incidence in Tehran metropolis: the first report from the Tehran population-based cancer registry, 1998-2001. *Arch Iran Med*, **12**, 15-23.

Mohebbi M, Wolfe R, Jolley D, et al (2011). The spatial distribution of esophageal and gastric cancer in Caspian region of Iran: an ecological analysis of diet and socio-economic influences. *Int J Health Geogr*, **10**, 13.

Natale-Pereira A, Enard KR, Nevarez L, Jones LA (2011). The

role of patient navigators in eliminating health disparities. *Cancer*, **117**, 3541-50.

Ngo TH, Barnard RJ, Leung PS, Cohen P, Aronson WJ (2003). Insulin-like growth factor I (IGF-I) and IGF binding protein-1 modulate prostate cancer cell growth and apoptosis: possible mediators for the effects of diet and exercise on cancer cell survival. *Endocrinology*, **144**, 2319-24.

Oliphant R, Brewster DH, Morrison DS (2011). The changing association between socioeconomic circumstances and the incidence of colorectal cancer: a population-based study. *Br J Cancer*, **104**, 1791-6.

Ozasa K, Watanabe Y, Ito Y, et al (2001). Dietary habits and risk of lung cancer death in a large-scale cohort study (JACC Study) in Japan by sex and smoking habit. *Jpn J Cancer Res*, **92**, 1259-69.

Parkin DM, Olsen AH, Sasieni P (2009). The potential for prevention of colorectal cancer in the UK. *Eur J Cancer Prev*, **18**, 179-90.

Pollock AM, Vickers N (1997). Breast, lung and colorectal cancer incidence and survival in South Thames Region, 1987-1992: the effect of social deprivation. *J Public Health Med*, **19**, 288-94.

Prentice RL, Thomson CA, Caan B, et al (2007). Low-fat dietary pattern and cancer incidence in the women's health initiative dietary modification randomized controlled trial. *J Natl Cancer Inst*, **99**, 1534-43.

Radosavljevic V, Jankovic S, Marinkovic J, Dokic M (2005). Diet and bladder cancer: a case-control study. *Int Urol Nephrol*, **37**, 283-9.

Randi G, Edefonti V, Ferraroni M, La Vecchia C, Decarli A (2010). Dietary patterns and the risk of colorectal cancer and adenomas. *Nutr Rev*, **68**, 389-408.

Riboli E, Norat T (2001). Cancer prevention and diet: opportunities in Europe. *Public Health Nutr*, **4**, 475-84.

Rohani-Rasaf M, Moradi-Lakeh M, Ramezani R, Asadi-Lari M (2012). Measuring socioeconomic disparities in cancer incidence in Tehran, 2008. *Asian Pac J Cancer Prev*, **13**, 2955-60.

Rohani RM, Rohani Rasaf MR, Rahimi F, et al (2011). Distribution of cancer incidence in districts and neighbourhoods of a number of Tehran districts in 1386. *Razi Journal of Medical Sciences,* **18**, 34-45.

Rothman KJ, Greenland S, Lash TL (2008). Nutritional Epidemiology. In: Rothman KJ, Greenland S, Lash TL, editors. Modern Epidemiology: Wolters Kluwer Health/ Lippincott Williams & Wilkins.

Sadjadi A, Nouraie M, Ghorbani A, Alimohammadian M, Malekzadeh R (2009). Epidemiology of breast cancer in the Islamic Republic of Iran: first results from a population-based cancer registry. *East Mediterr Health J*, **15**, 1426-31.

Schottenfeld D, Fraumeni JF (2006). Cancer epidemiology and prevention. Oxford; New York: Oxford University Press.

Silberstein JL, Parsons JK (2010). Evidence-based principles of bladder cancer and diet. *Urology*, **75**, 340-6.

Spadea T, d'Errico A, Demaria M, et al (2009). Educational inequalities in cancer incidence in Turin, Italy. *Eur J Cancer Prev*, **18**, 169-78.

Steenland K, Rodriguez C, Mondul A, Calle EE, Thun M (2004). Prostate cancer incidence and survival in relation to education (United States). *Cancer Causes Control*, **15**, 939-45.

Taylor VH, Misra M, Mukherjee SD (2009). Is red meat intake a risk factor for breast cancer among premenopausal women? *Breast Cancer Research and Treatment*, **117**, 1-8.

Trichopoulou A, Lagiou P, Kuper H, Trichopoulos D (2000). Cancer and mediterranean dietary traditions. *Cancer Epidemiol Biomarkers Prev*, **9**, 869-73.

Tseng M, Breslow RA, DeVellis RF, Ziegler RG (2004). Dietary patterns and prostate cancer risk in the National Health and Nutrition Examination Survey Epidemiological Follow-up Study cohort. *Cancer Epidemiol Biomarkers Prev*, **13**, 71-7.

van Dam RM, Huang Z, Giovannucci E, et al (2000). Diet and basal cell carcinoma of the skin in a prospective cohort of men. *Am J Clin Nutr*, **71**, 135-41.

van Dam RM, Huang Z, Rimm EB, et al (1999). Risk factors for basal cell carcinoma of the skin in men: results from the health professionals follow-up study. *Am J Epidemiol*, **150**, 459-68.

van Loon AJ, Goldbohm RA, van den Brandt PA (1998). Socioeconomic status and stomach cancer incidence in men: results from the Netherlands cohort study. *J Epidemiol Community Health*, **52**, 166-71.

Verhoeven DT, Assen N, Goldbohm RA, et al (1997). Vitamins C and E, retinol, beta-carotene and dietary fibre in relation to breast cancer risk: a prospective cohort study. *Br J Cancer*, **75**, 149-55.

Wang X-Q (2009). Review of salt consumption and stomach cancer risk: epidemiological and biological evidence. *World J Gastroenterology*, **15**, 2204.

Willett WC, Hunter DJ, Stampfer MJ, et al (1992). Dietary fat and fiber in relation to risk of breast cancer. An 8-year follow-up. *JAMA*, **268**, 2037-44.

World Cancer Research Fund ,American Institute for Cancer Research. Food, nutrition, physical activity, and the prevention of cancer: a global perspective. 2007 In: . Washington, DC: American Institute for Cancer Research.

Wu AH, Ziegler RG, Pike MC, et al (1996). Menstrual and reproductive factors and risk of breast cancer in Asian-Americans. *Br J Cancer*, **73**, 680-6.

Yiengprugsawan V, Lim LLY, Carmichael GA, Sidorenko A, Sleigh AC (2007). Measuring and decomposing inequity in self-reported morbidity and self-assessed health in Thailand. *Int J Equity Health*, **6**, 23.

Yin D, Morris C, Allen M, et al (2010). Does socioeconomic disparity in cancer incidence vary across racial/ethnic groups? *Cancer Causes Control*, **21**, 1721-30.

Zendehdel K, Sedighi Z, Hassanloo J, Nahvijou A (2010). Improving quality of cancer registration in Iran. part 1: evaluation and comparison of cancer registration results in the country. *Hakim Res J*, **12**, 42-9.