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SPATIAL PATTERNS AND PREVALENCE OF CANCER MORBIDITY IN THE PUNJAB DURING 2015-2020

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ABSTRACT

Cancer is a major health problem in the underdeveloped and developed countries of the world. This study was performed to assess the spatial patterns of cancer incidence in the Punjab Province, Pakistan, based on the cancer registry data. A retrospective study was conducted, and data were collected from 11 hospitals dealing in cancer at provincial level and Pakistan Society of Clinical Oncology. A total of 13,448 new cases were diagnosed with cancer during 2015-2020 in the Punjab Province. The highest Standardized morbidity rate (SMR) was observed in Lahore, Faisalabad, and Gujranwala, Gujrat, Khushab and Mandi Bahauddin districts. Breast cancer incidence was found the most common type followed by lover, ovary, and prostate cancer. Cancer morbidity was also found higher in females than the males within the study area. Disease sex ratio was found higher in Rawalpindi and Mandi Bahauddin districts and lower in Bahawalpur and Bahawalnagar districts. These findings may help to identify spatial anomalies in cancer incidence in the Punjab province and can stimulate further research on the possible causes underlying these clusters and associations. This can be of great importance and interest to researchers for the future epidemiological studies, and to policymakers for applying preventive measures.

KEY WORDS: Cancer Morbidity, Prevalence, Standardized morbidity rate, Sex Disease Ratio, ArcGIS 10.5, Punjab.

1. INTRODUCTION

Cancer is one of the main health problems of present day, as it is the one of leading cause of morbidity and mortality in the modern world (Hafeez et al. 2020; Bray et al. 2021; WHO 2020). Every sixth death in the world is caused by any type of cancer as every year more than nine million people die due to cancer (Ritchie 2019). At global level, this fatal disease is consistently increasing and becoming more prevalent with high incidence rate even in the low and middle income countries (Goli et al. 2013). According to World Health Organization (WHO) during 2019, approximately 14 million new cases of cancer and 8.2 million cancer related deaths were reported at worldwide level. More than 60% of world's total new annual cases occur in Africa, Asia and Central and South America while as these regions account for 70% of the world's cancer mortality (WHO 2021). According to American Institute for Cancer

Research, the cancer incidence rate is found higher in countries with high Human Development Index (HDI) i.e. 2.5 times higher in countries with very high HDI compared with countries having low HDI (WCRF 2020). Likewise, gender wise variation is also seen in cancer incidence throughout the world and gender effects on cancer risk, treatment and prevention are also considerable. Tremendous exposure to smoking habits, environmental and occupational factors has led to a rapid increase in cancer morbidity especially in the last two decades (Merletti et al. 2011). The lack of equal access to healthcare services, community status, adoption of western lifestyle, and increased old age have led that the burden of cancer has changed during recent decades, and Pakistan is not an exemption from these conditions (Sadjadi et al. 2015; Babaei et al. 2015).

In developing countries like Pakistan, the incidence of cancer is on the rise. Annually, 1.4 to 1.67 million cases hovered during 2014 (Azad 2014). According to Global Cancer Observatory, 178,388 new cancer cases were reported in Pakistan during 2020, while as the number of prevalent cancer cases in last 5 years was 329,547. Pakistani women are found to be more affected by cancer than Pakistani males as 90,373 new cases of cancers were reported among females compared to 88,015 cancer cases among males in 2020 (GLOBOCAN 2020). The most common diagnosed cancer is lip, oral cavity cancer among males and breast cancer among females within the country. The contributing factors towards increased cancer morbidity in the country are smoking, prevailing infections, occupational risks, obesity, and penetration of ultraviolet rays WHO (2020). Punjab, being the largest and most populous province of the country is most affected by this fatal disease (Shaharyar 2012).

The spatial analysis of disease incidence data, known as disease mapping, is a dynamic area of biostatistical, epidemiological, and public health research. For a disease like cancer, it is important to understand the spatial and temporal distribution of its prevalence within ang region (Naish et al. 2011). Using geographical mapping, one can detect hot-spots of disease incidence in which nearby areas are often related because they share similar risk factors. This attention has led to a greater use of geographical, GIS, and spatial analysis tools in studying data routinely collected for public health purposes. Disease mapping is commonly used to describe the variation in health outcomes over geographic regions (Oleson et al. 2018). The aim of the present study is to spatially analyze the morbidity and incidence patterns of cancer prevalence among the various districts of Punjab and to determine the gender differences found within the study area.

1.1. Study Area

The present study was carried out in the Punjab Province (F. 1). It is situated at 27°.42′ to 34°.02′ North latitude and 69°.81′ to 75°.23′ East longitudes. It is bounded on the north by KPK and Federal Capital Territory of Islamabad, on the northeast by Azad Jammu and Kashmir, on the east and south by India, on the south-west by Sindh and on the west by Baluchistan. Punjab is the most populous province of the country with a population size of 110,012,442 persons. The region mainly comprises of levelled plains with some mountainous and hilly regions in its northwest and extreme southwest and a desert towards its south-eastern margins. Administratively, the province comprises of 9 administrative divisions and 36 districts (GOP 2017).

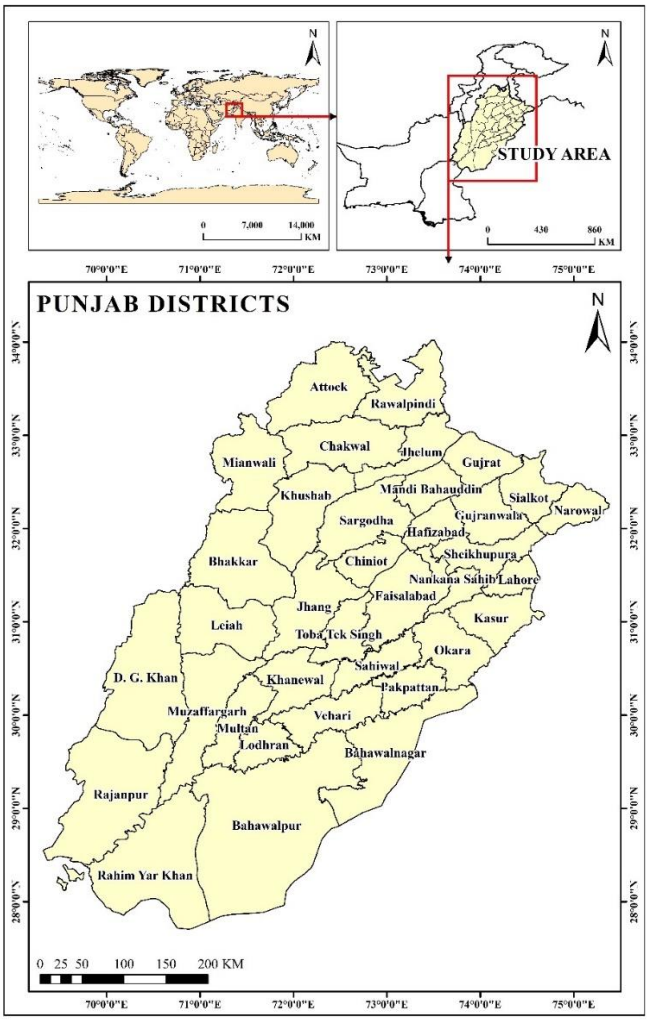


Fig. 1 Punjab-The Study Area

2. MATERIAL AND METHOD

A retrospective research design was adopted and epidemiological records of diagnosed cancer types during 2015-2020 were obtained. Currently, there are 11 hospitals that cater most of the cancer cases and provide specialized treatments to cancer patients within the study area. Therefore, out of these 11 hospitals, the following Six hospitals were visited personally, and the epidemiological records of cancer were collected through a structured proforma.

- Combined Military Hospital (CMH), Lahore
- Institute of Nuclear Medicine and Oncology (INMOL), Lahore
- Jinnah Hospital, Lahore
- Mayo Hospital, Lahore
- Sir Ganga Ram hospital, Lahore
- Shaukat Khanum Cancer Hospital, Lahore

While as the cancer records of remaining five hospitals i.e. Allied hospital Faisalabad, Sargodha Medical College, Nishtar hospital Multan, CMH Rawalpindi and Sheikh Zayed hospital Rahim Yar Khan Hospital were obtained from Pakistan Society of Clinical Oncology (PSCO). PSCO was established on 21st November 1999, and it maintains data on cancer patients at provincial level. The necessary permissions were obtained from these institutes prior to data collection. Moreover, the demographic data of district level population was taken from the Bureau of statistics Punjab, Lahore. The collected data information from each source was further processed using MS Excel 365 and categorized district wise and gender wise. Furthermore, Standardized morbidity incidence rates (SMR) per 100,000 were calculated through SPSS version 22 through the following formula:

$$\boldsymbol{SMR(i)} = \frac{\boldsymbol{O(i)}}{\boldsymbol{E(i)}}$$

$O(i)$ is observed number of cases in a given period of time in an area i (i= 1, 2, 3, 4, 5,…n)

$$\boldsymbol{E(i)} = \boldsymbol{\theta} \times \boldsymbol{N(i)}$$

and

$$\boldsymbol{\theta} = \sum_{j=1}^{n} \mathrm{O(j)} \,/\, \sum_{j=1}^{n} \mathrm{N(j)}$$

Where

$E(i)$ is expected number of cases in district i

$N(i)$ is the total population in district i

$O(j)$ is the observed number of cases in the district of Punjab

$N(j)$ is the total population in all districts of province Punjab

To find out the SMR of reported cancer cases in the Punjab during the reference period 2015-2020, the population figures of 1998 census was utilized as base year.

Additionally, disease sex ratio is also an important measure to determine the pattern and prevalence of a disease among both genders in any geographical region. The following formula was applied to calculate disease sex ration:

$$\textbf{Disease Sex Ratio} = \frac{\text{Total number of male cancer patient}}{\text{Total number of female cancer patient}} \times 100$$

Furthermore, few thematic maps were also prepared in ArcGIS 10.5 to show the spread, intensity of disease through choropleth, dot density and graduated circle techniques.

3. RESULTS & DISCUSSIONS

According to the collected data, a total number of 13,448 diagnosed cancer cases were found in the districts of the Punjab during the study period 2015-2020 (Table 1).

Table 1. Cancer prevalence at district level during 2015-2020

Sr.	Districts	Population (1998)	Observed Cases	Expected Cases	SMR
1	Attock	1,274,935	104	229.488	0.453
2	Bahawalnagar	2,061,447	86	371.060	0.232
3	Bahawalpur	2,433,091	80	437.956	0.183
4	Bhakkar	1,051,456	103	189.262	0.544
5	Chakwal	1,083,725	180	195.071	0.923
6	Chiniot	965,124	0	172.102	0
7	Dera Ghazi Khan	2,643,118	17	475.761	0.036
8	Faisalabad	5,429,547	2,609	977.318	2.666
9	Gujranwala	3,400,940	804	612.169	1.313
10	Gujrat	2,048,008	583	368.641	1.581
11	Hafizabad	832,980	58	149.936	0.387
12	Jhang	2,834,546	163	510.218	0.319
13	Jhelum	936,957	165	168.652	0.978
14	Kasur	3,466,000	69	623.880	0.111
15	Khanewal	2,068,490	89	372.328	0.239

16	Khushab	1,205,460	271	216.982	1.249
17	Lahore	6,318,745	4,155	1137.374	3.653
18	Layyah	1,120,951	36	201.771	0.178
19	Lodhran	1,171,800	04	210.924	0.019
20	Mandi Bahauddin	1,160,552	288	208.899	1.379
21	Mianwali	1,056,620	180	190.192	0.946
22	Multan	3,116,851	262	561.033	0.467
23	Muzaffargarh	2,635,903	24	474.462	0.051
24	Nankana Sahib	1,410,000	377	253.800	1.485
25	Narowal	1,265,097	157	227.717	0.689
26	Okara	2,232,992	184	401.939	0.458
27	Pakpattan	1,286,680	156	228.362	0.683
28	Rahim yar khan	3,141,053	248	565.389	0.437
29	Rajanpur	1,103,618	09	198.651	0.045
30	Rawalpindi	3,363,911	427	605.504	0.705
31	Sahiwal	1,843,194	160	331.774	0.482
32	Sargodha	2,665,979	292	479.876	0.608
33	Sheikhupura	3,321,029	168	597.785	0.281
34	Sialkot	2,723,481	642	490.227	1.309
35	Toba Tek Singh	1,621,593	131	291.887	0.449
36	Vehari	2,090,416	67	376.275	0.178
Total		73,621,290	13,448	---	1.000

Source: Selected Cancer Hospitals and PSC0, 2020

As Table 1 shows, the highest prevalence of cancer was found at Lahore and Faisalabad districts with 4,155(19.4%) and 2,609(30.9%) cancer patients respectively. The other districts with high cancer prevalence were Gujranwala, Sialkot, Gujrat, and Rawalpindi districts yet each of them had cancer cases less than 1,000 patients. While as, a negligible prevalence of the disease was seen at Lodhran and Rajanpur districts where only 04 and 09 cases were reported during the study period. The other districts with low cancer prevalence were D.G.Khan, Muzaffargarh, Layyah etc. as each of them had reported cancer cases less than 50 (See Fig. 2).

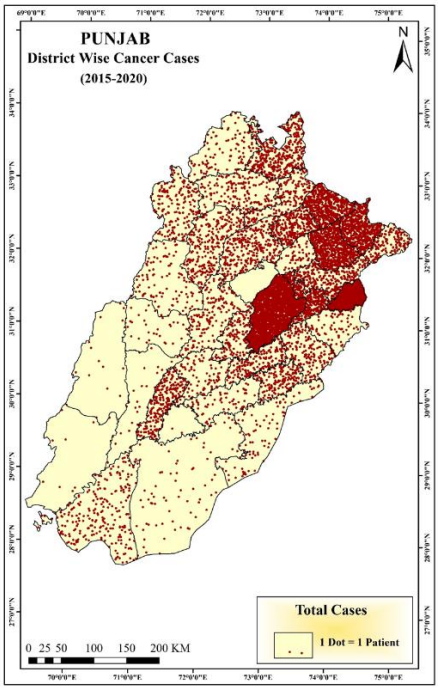
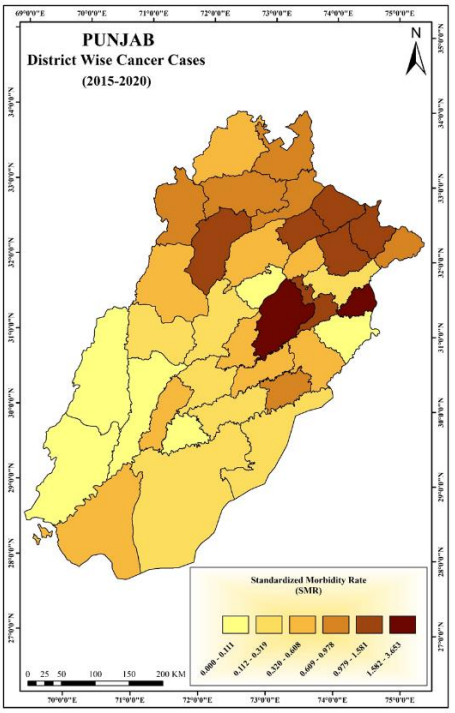


Fig. 2 District wise Cancer Prevalence in Punjab (2015-2020)



F.3 District-wise SMR in the Punjab (2015-2020)

In addition to this, a very alarming situation was observed in terms of SMR, as 08 districts of the study area were identified with a high SMR greater than 1. These included Lahore and Faisalabad districts on the top with SMR greater than 3 and 2 respectively. The other districts with SMR greater than 1 included Gujrat, Nankana Sahib, Mandi Bahauddin, Gujranwala, Sialkot, and Khushab (F. 3).

Moreover, the prevalence of cancer morbidity was also analyzed by its major types within the Punjab during 2015-2020, the results are enumerated in Table 2.

Table 2. Cancer Morbidity by types in the Punjab during 2015-2020

Sr.	Cancer Type	Observed Cases	%
1	Breast	5,670	42.16
2	Liver	1,669	12.41
3	Ovary	1,658	12.33
4	Prostate	1,330	9.89
5	Lung	1,151	8.56
6	Bladder	1,083	8.05
7	Lymphoma	667	4.96
8	Leukemia	220	1.64
Total		13,448	100.00

Source: Selected Cancer Hospitals and PSC0, 2020

As the Table 2 shows, eight types of cancer types were found to responsible for cancer morbidity in the Punjab. Amon them, Breast Cancer was found to be the most common type of cancer with a share of 42.16% in the total observed cancer cases. The other common types included Liver Cancer, Ovary Cancer, and Prostate Cancer. However, the least common cancer types were Lymphoma and Leukemia each sharing less than 5% in the total burden of disease caused by cancer in the Punjab province during 2015-2020 (F. 4).

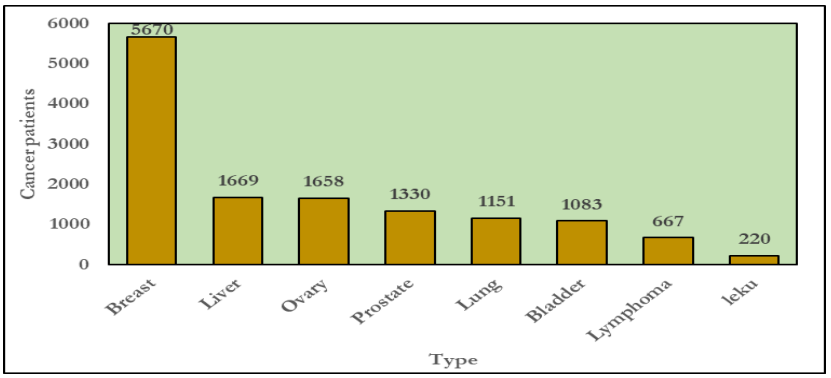


Fig. 4 Cancer Morbidity by types in the study area (2015-2020)

Moreover, the patterns of cancer morbidity were also analyzed gender wise in all districts of the study area during the reference period 2015 to 2020 (see Table 3).

Table 3. Cancer Prevalence by Gender in the Punjab during 2015-2020

Sr.	Districts	Male	Female	Disease Sex Ratio
1	Attock	37	67	55.2
2	Bahawalnagar	19	67	28.4
3	Bahawalpur	2	78	2.6
4	Bhakkar	36	67	53.7
5	Chakwal	113	67	168.7
6	Chiniot	-	-	-
7	Dera Ghazi Khan	09	08	112.5
8	Faisalabad	821	1,788	45.9
9	Gujranwala	202	602	33.6
10	Gujrat	210	373	56.3
11	Hafizabad	24	34	70.6
12	Jhang	94	69	136.2
13	Jhelum	117	48	243.8
14	Kasur	16	53	30.2
15	Khanewal	62	27	229.6
16	Khushab	87	184	47.3
17	Lahore	1,496	2,659	56.3
18	Layyah	26	10	260.0
19	Lodhran	04	-	-
20	Mandi Bahauddin	236	52	453.8
21	Mianwali	90	90	100.0
22	Multan	112	150	74.7
23	Muzaffargarh	24	-	-
24	Nankana Sahib	111	266	41.7
25	Narowal	71	86	82.6
26	Okara	118	66	178.8
27	Pakpattan	74	82	90.2
28	Rahim Yar Khan	112	136	82.4
29	Rajanpur	-	09	-
30	Rawalpindi	272	155	175.5
31	Sahiwal	65	95	68.4
32	Sargodha	104	188	55.3
33	Sheikhupura	74	194	38.1
34	Sialkot	204	438	46.6
35	Toba Tek Singh	44	87	50.6
36	Vehari	43	24	179.2
Total		5,129	8,319	61.7

Source: Selected Cancer Hospitals and PSC0, 2020

As the Table 3 shows, cancer morbidity was found more common in females than in the males with 8,316(61.86%) and 5,129(38.14%) cancer cases respectively within the Punjab province during 2015-2020. Generally, the highest number of female cancer patients were observed at Lahore and Faisalabad districts with 2,659 and 1,788 female patients respectively. The other prominent districts with high cancer morbidity among females included Gujranwala, Sialkot, Gujrat, Nankana Sahib, Sheikhupura, Sargodha and Khushab. Moreover, no female cancer patient was found at Lodhran, Chiniot and Muzaffargarh districts.

Similarly, highest cancer morbidity among male patients than females was found at Rawalpindi district with 272 diagnosed cancer cases. The other districts with higher male cancer morbidity included Mandi Bahauddin, Okara, Jhelum, Chakwal etc. Besides no male cancer patient was observed at Chiniot and Rajanpur districts (See F. 5).

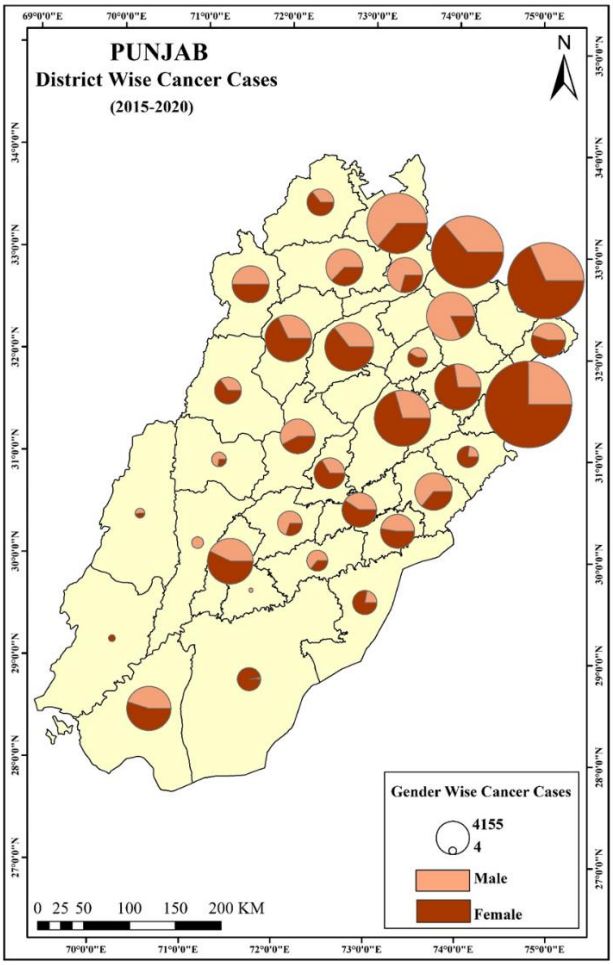


Fig. 5 Cancer Morbidity by Genders in Punjab (2015-2020)

The results for Disease sex ratio were quite eye opening (See Table 3 and F. 6). The highest disease sex ratio was exhibited by Mandi Bahauddin, followed by Layyah, Jhelum, Khanewal districts etc. the lowest Disease sex ratio was seen at Bahawalpur, Bahawalnagar, Kasur, Gujranwala, Sheikhupura etc. Besides, disease sex ratio was not calculated for Chiniot, Lodhran, Muzaffargarh and Rajanpur districts due to absence of either male or female cancer patients.

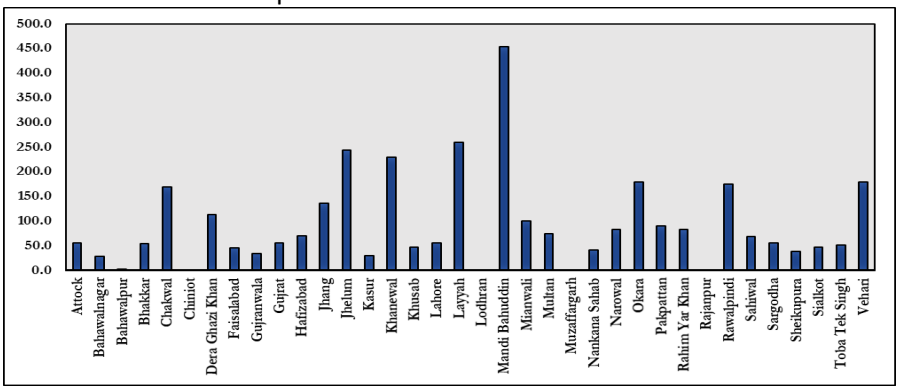


Fig. 6 District-wise comparison of Disease Sex Ratio of cancer patients (2015-2020)

4. CONCLUSION

The following conclusions are made from the above mentioned results and the discussions: At present, little is known about the spatial pattern of the most common cancers in the Punjab. The disease incidence is found most prevalent in 04 districts of the Punjab i.e. Lahore, Faisalabad, Gujranwala and Sialkot. This might be to the facts that these districts are not only the overcrowded and most urbanized districts but also are major industrial hubs of the province. The distribution pattern of cancer varies greatly within the Punjab province on gender basis as it was found more frequent in females than in males. Women at high risk for cancer can be because of their family history, a genetic tendency, or certain other factors.

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CONFLICT OF INTEREST

Authors declared no conflict of interest.

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