

ORIGINAL ARTICLE

Lung cancer incidence and mortality in China, 2009

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Keywords

epidemiology; incidence; lung cancer; mortality; cancer registry.

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Abstract

Background: The National Central Cancer Registry (NCCR) is a governmental organization for cancer surveillance affiliated to the Bureau of Disease Control, Ministry of Health, in China. It annually collects cancer registration data from local registries and then analyzes and publishes the results to provide useful information for making anti-cancer policy, program evaluation, and etiology research. At the end of 2012, the NCCR reported cancer statistics for 2009.

Methods: By mid 2012, 104 population-based cancer registries reported cancer incidence and mortality data, including demographic information, for 2009, to the NCCR. After an evaluation procedure, a total of 72 registries' data met the criteria, which was then compiled for analysis. Individual lung cancer cases were retrieved from the national database based on the International Classification of Diseases (ICD)-10 topography code as "C33, C34," including cancers of the trachea and bronchus. The crude incidence and mortality rates of lung cancer were calculated by gender, age, and location (urban/rural). China's population in 1982 and Segi's population structures were used for age-standardized rates.

Results: In cancer registration areas in 2009, lung cancer was the most common cancer in China and in urban areas, the second most common cancer in rural areas. It was the leading cause of cancer death both in males and females, urban and rural areas. The incidence and mortality rates of lung cancer were higher in males than those in females, and in urban areas than in rural areas. The age-specific incidence and mortality rates showed that both rates were relatively low for those aged under 50 years, but dramatically increased and reached a peak in the age group of 80–84 years.

Conclusion: Lung cancer is the most common cancer in China and leading cause of cancer death. Primary and secondary prevention should be carried out in each group, such as tobacco control and early detection.

Introduction

Lung cancer is the most common and fatal cancer in the world.¹ In China, lung cancer has been the leading cause of cancer death since the 1990s.² According to recent trend analysis, the incidence of lung cancer has increased over the last 20 years and it is predicted that the disease burden will continue if no effective action on lung cancer control is taken.³ Men in urban areas are the highest risk group for lung cancer, likely resulting from cigarette smoking and an increase in air pollution with the constant promotion of industrialization and urbanization in China.

The National Cancer Registration Center established the Chinese Cancer registration annual report system to comprehensively promote cancer registration. The Chinese Cancer Registry Annual report has been published since 2008, which provides base scientific data for cancer prevention and control in China. In 2012, the National Cancer Registry Center collected data for calendar year 2009 from 104 registries. After comprehensive quality evaluation, data from 72 registries were included in the annual report to reflect cancer incidence and mortality in the registration areas in 2009. In this study, lung cancer cases were retrieved from the national database for analysis.

Material and methods

Data source

The NCCR of China was responsible for cancer data collection, evaluation, analysis, and publication from population-based cancer registries. All new cancer cases diagnosed in 2009 were reported to cancer registries from all hospitals, community health centers, and other departments, including centers of township medical insurance, and the new-type Rural Cooperative Medical System. The death record database was linked and matched with the cancer registration database for identifying cancer deaths and supplementing missed cases.

By mid 2012, there were 104 cancer registries (46 cities and 58 counties) from 27 provinces reporting cancer registration data to the NCCR. The overall population coverage was 109 476 347, accounting for 8.20% of the whole population. The cancer registries coded cancer site and histology by the International Classification of Diseases (ICD) for Oncology, third edition, and ICD-10. Invasive cases of lung cancer (C33–C34) were drawn and analyzed from the overall cancer database. The local statistics bureau provided demographic information.

Quality control

Based on the “Guideline of Chinese Cancer Registration” and the standard of data inclusion in “Cancer Incidence in Five Continents Volume IX,” cancer registration data was evaluated by the quality indicators of proportion of morphological verification (MV%), percentage of cancer cases identified with death certification only (DCO%) and mortality to incidence ratio (M/I).^{4–6} The detailed standard for data inclusion has been discussed previously.⁷ Generally, data with a DCO% of less than 20%, an overall MV% of more than 55%, and a M/I between 0.55–0.95 were considered acceptable.

Statistical analysis

Crude incidence and mortality rates of lung cancer were prepared by sex, area, and for 19 age groups (0–, 1–4, 5–9, 80–84, 85+ years). Age-standardized rates were calculated using the Chinese population (1982) and World Segi’s population. The cumulative risk of developing or dying from cancer before reaching 75 years of age (in the absence of competing causes of death) was calculated and presented as a percentage. Software including MS-FoxPro, MS-Excel, IARCcrgTools issued by the International Agency for Research on Cancer (IARC) and the International Association of Cancer Registries (IACR) were used for data check-up. SAS software was used to calculate the incidence and mortality rates.

Results

Compiled data

After an evaluation process for all submitted data, data from 72 population-based cancer registries was accepted for the annual report. The population covered by these cancer registries was 85 470 522, including 43 231 554 males and 42 238 968 females, accounting for 6.40% of the whole population. Among them, 31 registries were from urban areas, including 57 489 009 members of the population. Forty-one registries were from rural areas, covering a total of 27 981 513 members of the population. The MV%, DCO%, and M/I ratios for the national compiled data were 50.76%, 4.88%, and 0.85, respectively. In urban areas, the MV%, DCO%, and M/I ratios were 55.03%, 4.71%, and 0.86, respectively. In rural areas, they were 38.68%, 5.35%, and 0.84. There were 45 784 new cases diagnosed with lung cancer in 2009. Of these, 30 435 were males and 15 349 were females. The number of overall cancer deaths was 38 946, including 26 373 males and 12 573 females. Detailed information on population extent, incidence, and death of lung cancer in each cancer registry is shown in Table 1.

Incidence

The crude incidence rate for lung cancer was 53.57/100 000 in 2009, accounting for 18.74% of overall new cancer cases, ranked the first in all cancer sites. The age-standardized rates by China (CASR) population and by World population (WASR) were 25.34/100 000 and 34.41/100 000, respectively. Among those aged under 75, the cumulative incidence rate was 4.16%.

Lung cancer occurred more often among men than among women. For men, lung cancer was the most common cancer with a crude incidence rate of 70.40/100 000, whereas the CASR and WASR were 34.75/100 000 and 47.48/100 000, respectively. For women, lung cancer was the second most common cancer following breast cancer, with a crude incidence rate of 36.34/100 000, whereas the CASR and WASR were 16.41/100 000 and 22.20/100 000, respectively. The crude incidence rate in urban areas was 58.81/100 000 and it was higher than that in rural areas (42.80/100 000), ranked first and second, respectively. After age standardization, the incidence rate in urban areas (36.05/100 000 for WASR) was still higher than those in rural (30.53/100 000 for WASR) (Table 2).

Age-specific incidence rates of lung cancer for both genders and areas were compared. Overall, the age-specific incidence rate was relatively low in subjects under 50 years old. However, the rate dramatically increased for patients over 50 years old, reaching a peak for subjects of 80–84 years old, both in men and women. After the age of 50, the lung

Table 1 Population, number of new cases, and deaths of lung cancer in cancer registries in 2009

Registry	Urban = 1 Rural = 2	Population			New cancer cases			Cancer death		
		Both	Male	Female	Both	Male	Female	Both	Male	Female
Beijing	1	7645186	3859586	3785600	4598	2801	1797	4004	2499	1505
Qianxi	2	361312	182138	179174	147	108	39	55	43	12
Shexian	2	394944	205168	189776	85	55	30	86	60	26
Cixian	2	634333	322621	311712	237	149	88	190	129	61
Baoding	1	948612	478051	470561	601	399	202	481	272	209
Yangquan	1	683165	346023	337142	262	200	62	211	162	49
Yangcheng	2	383165	192119	191046	70	50	20	54	42	12
Chifeng	1	1203006	613725	589281	471	279	192	381	230	151
Shenyang	1	3497815	1722976	1774839	2702	1640	1062	2466	1453	1013
Dalian	1	2266224	1136772	1129452	1942	1201	741	1449	953	496
Zhuanghe	2	915660	461826	453834	499	270	229	493	285	208
An'shan	1	1471775	731916	739859	1140	709	431	1065	670	395
Benxi	1	955409	475113	480296	531	334	197	527	332	195
Dandong	1	767011	378794	388217	503	309	194	492	322	170
Donggang	2	640853	323798	317055	476	274	202	318	181	137
Dehui	2	943395	479486	463909	531	330	201	366	234	132
Yanji	2	440957	215260	225697	143	95	48	113	79	34
Daoli District, Harbin	1	713264	351071	362193	536	342	194	349	213	136
Nangang District, Harbin	1	1020233	508921	511312	626	388	238	582	362	220
Shangzhi	2	616046	314864	301182	350	222	128	209	125	84
Shanghai	1	6181334	3084496	3096838	4111	2697	1414	3609	2446	1163
Jintan	2	545000	262407	282593	211	157	54	233	176	57
Suzhou	1	2392087	1183716	1208371	1319	934	385	982	701	281
Haian	2	936785	463612	473173	382	256	126	349	234	115
Qidong	2	1114951	548805	566146	744	535	209	694	514	180
Haimen	2	1016228	501407	514821	812	543	269	693	499	194
Lianyungang	1	886862	452358	434504	333	241	92	284	212	72
Donghai	2	1117858	579751	538107	432	292	140	389	273	116
Guanyun	2	1015229	534502	480727	339	229	110	314	212	102
Chuzhou District, Huai'an	1	1174877	609088	565789	358	239	119	290	199	91
Huaiyin District, Huai'an	1	900027	465502	434525	361	280	81	283	213	70
Xuyi	2	759450	388180	371270	310	219	91	212	139	73
Jinhu	2	352292	176689	175603	130	90	40	124	86	38
Sheyang	2	965817	494682	471135	490	322	168	442	295	147
Jianhu	2	805465	410369	395096	256	161	95	243	164	79
Dafeng	2	724147	363326	360821	397	250	147	319	204	115
Yangzhong	2	272046	134758	137288	82	59	23	86	64	22
Taixing	2	1128840	613199	515641	273	204	69	270	202	68
Hangzhou	1	6753509	3403893	3349616	3966	2777	1189	3387	2439	948
Jiaxing	1	509367	253819	255548	280	204	76	238	176	62
Jiashan	2	382475	189692	192783	273	209	64	236	190	46
Haining	2	653957	322969	330988	396	278	118	317	225	92
Shangyu	2	771321	383462	387859	430	311	119	341	246	95
Xianju	2	490070	255438	234632	165	122	43	153	111	42
Feixi	2	858895	449882	409013	252	192	60	224	173	51
Maanshan	1	633477	323834	309643	341	241	100	320	255	65
Tongling	1	433545	221375	212170	207	158	49	152	108	44
Changle	2	673717	355091	318626	168	102	66	126	79	47
Xiamen	1	1160135	583873	576262	591	412	179	460	349	111
Zhanggong District, Ganzhou	1	420759	212159	208600	192	142	50	156	106	50
Linqu	2	817857	417434	400423	544	358	186	414	276	138
Wenshang	2	762828	388454	374374	231	159	72	225	152	73
Feicheng	2	733501	358739	374762	332	225	107	273	188	85
Yanshi	2	602266	306192	296074	122	76	46	99	57	42
Linzhou	2	1080241	557392	522849	173	94	79	131	80	51
Xiping	2	858002	434899	423103	380	247	133	353	234	119
Wuhan	1	4832174	2484622	2347552	2604	1892	712	2048	1507	541
Yunmeng	2	524801	261237	263564	158	124	34	186	145	41
Hengdong	2	713458	373923	339535	297	231	66	186	146	40
Guangzhou	1	3968216	2014580	1953636	2495	1656	839	2521	1696	825
Sihui	2	413363	211351	202012	188	131	57	122	90	32
Zhongshan	1	1468391	732333	736058	598	396	202	482	331	151
Liuzhou	1	1038208	533050	505158	506	354	152	370	264	106
Fusui	2	444332	236000	208332	94	64	30	85	65	20
Jiulongpo District, Chongqing	1	798618	402961	395657	457	331	126	469	360	109
Qingyang District, Chengdu	1	534701	277154	257547	335	232	103	252	175	77
Ziliujing District, Zigong	1	357600	179873	177727	271	186	85	156	126	30
Yanting	2	610103	316499	293604	233	181	52	198	154	44
Jingtai	2	233609	119953	113656	54	36	18	42	28	14
Liangzhou District, Wuwei	1	990583	524276	466307	247	153	94	235	150	85
Xining	1	882839	439175	443664	325	233	92	225	171	54
Xinyuan	2	271944	138895	133049	89	65	24	57	42	15
Total		85470522	43231554	42238968	45784	30435	15349	38946	26373	12573

Table 2 Lung cancer incidence by sex and area in registration areas in 2009

Location	Sex	Cases	Crude rate (1/10 ⁵)	Ratio	ASIRC (1/10 ⁵)	ASIRW (1/10 ⁵)	Cumulative rate 0–74, (%)	Rank
All areas	Both sex	45784	53.57	18.74	25.34	34.41	4.16	1
	Male	30435	70.40	22.14	34.75	47.48	5.70	1
	Female	15349	36.34	14.36	16.41	22.20	2.67	2
Urban	Both sex	33809	58.81	19.38	26.46	36.05	4.34	1
	Male	22360	77.14	23.36	36.32	49.81	5.95	1
	Female	11449	40.17	14.55	17.22	23.35	2.81	2
Rural	Both sex	11975	42.80	17.12	22.69	30.53	3.76	2
	Male	8075	56.68	19.34	31.08	42.01	5.16	2
	Female	3900	28.39	13.83	14.49	19.45	2.35	2

ASIRC, age standardized incidence rate by Chinese population; ASIRW, age standardized incidence rate by world population.

cancer age-specific incidence rate was more than double in men than in women, although slight differences were seen in those patients under 50 years old. Compared to the different locations, age specific lung cancer rates in urban areas were generally higher than those in rural areas, both in men and women, especially in older age groups. (Table 3, Fig 1)

Mortality

The crude mortality rate for lung cancer was 45.57/100 000 in 2009, accounting for 25.24% of cancer deaths in 2009. The CASR and WASR for mortality were 20.61/100 000 and 28.44/100 000, respectively. Among patients between the ages of 0–74, the cumulative rate was 3.31%.

The mortality rate of lung cancer was much higher in males than in females. In males, the crude rate, CASR, and WASR were 61.00/100 000, 29.15/100 000, and 40.46/100 000, respectively. In females, the crude rate, CASR, and WASR were 29.77/100 000, 12.58/100 000, and 17.34/100 000, respectively. In urban areas, the crude rate, CASR and WASR were 50.32/100 000, 21.49/100 000, and 29.79/100 000. In rural areas, they were 35.81/100 000, 18.49/100 000, and 25.12/100 000, lower than those in urban areas. Lung cancer was the leading cause of cancer death, both in men and women, in urban and rural areas. (Table 4)

Age-specific mortality rates by gender and area are shown in Table 5 and Figure 2. The mortalities were relatively lower in age groups under 50 and reached a peak in the age group of

Table 3 Age-specific incidence rates of lung cancer in cancer registration areas in 2009 (1/10⁵)

Age group	All areas			Urban			Rural		
	Both	Male	Female	Both	Male	Female	Both	Male	Female
All	53.57	70.40	36.34	58.81	77.14	40.17	42.80	56.68	28.39
0-	0.16	0.31	0.00	0.00	0.00	0.00	0.42	0.79	0.00
1-	0.04	0.07	0.00	0.00	0.00	0.00	0.10	0.18	0.00
5-	0.03	0.00	0.06	0.05	0.00	0.10	0.00	0.00	0.00
10-	0.07	0.08	0.05	0.04	0.07	0.00	0.10	0.10	0.11
15-	0.11	0.04	0.19	0.11	0.06	0.17	0.11	0.00	0.22
20-	0.42	0.58	0.25	0.37	0.52	0.20	0.56	0.73	0.38
25-	0.88	0.98	0.79	0.84	0.90	0.77	0.99	1.15	0.82
30-	1.94	2.12	1.76	1.84	1.62	2.07	2.12	3.02	1.20
35-	5.70	6.37	5.02	6.21	6.74	5.68	4.69	5.65	3.71
40-	14.81	17.08	12.49	14.23	16.83	11.59	15.98	17.58	14.33
45-	26.83	33.17	20.25	27.98	34.50	21.19	24.22	30.14	18.13
50-	55.72	73.52	37.36	57.07	76.16	37.49	52.28	66.89	37.02
55-	93.57	129.59	57.32	93.99	132.17	56.25	92.56	123.61	59.94
60-	136.79	191.09	82.30	138.29	194.67	83.05	133.53	183.64	80.62
65-	197.93	278.24	119.50	211.52	300.14	127.39	170.86	236.43	103.10
70-	297.52	406.27	197.57	315.44	424.71	216.74	254.43	363.25	150.15
75-	379.21	540.21	236.15	406.38	569.87	259.71	308.63	461.74	175.92
80-	405.98	581.66	266.55	447.42	639.35	291.37	301.15	428.54	206.08
85-	322.56	504.16	207.63	363.48	565.26	232.51	215.80	335.46	144.93

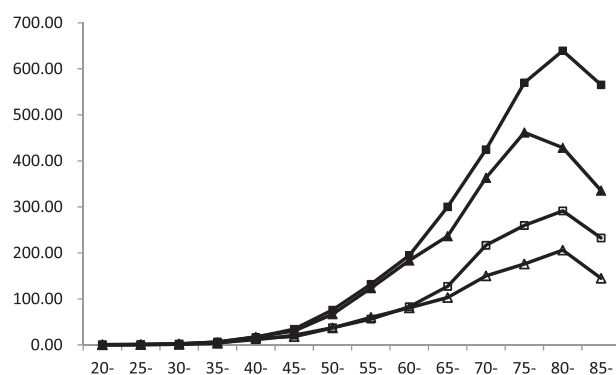


Figure 1 Age-specific incidence rate of lung cancer in cancer registration areas in 2009 ($1/10^5$), —■—, urban male; —●—, urban female; —▲—, rural male; —◆—, rural female.

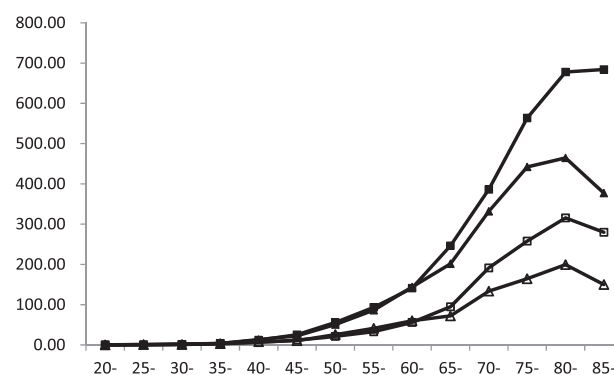


Figure 2 Age-specific mortality of lung cancer in cancer registration areas in 2009 ($1/10^5$), —■—, urban male; —●—, urban female; —▲—, rural male; —◆—, rural female.

Table 4 Cancer mortality of lung cancer in cancer registration areas in 2009

Location	Sex	Cases	Crude rate ($1/10^5$)	Ratio	ASIRC ($1/10^5$)	ASIRW ($1/10^5$)	Cumulative rate 0–74, (%)	Rank
All areas	Both sex	38946	45.57	25.24	20.61	28.44	3.31	1
	Male	26373	61.00	27.21	29.15	40.46	4.66	1
	Female	12573	29.77	21.91	12.58	17.34	2.01	1
Urban	Both sex	28926	50.32	27.67	21.49	29.79	3.43	1
	Male	19452	67.11	30.03	30.39	42.39	4.84	1
	Female	9474	33.24	23.81	13.20	18.30	2.10	1
Rural	Both sex	10020	35.81	20.14	18.49	25.12	3.04	1
	Male	6921	48.58	21.52	26.16	35.74	4.29	1
	Female	3099	22.56	17.61	11.09	15.03	1.78	1

ASIRC, age standardized incidence rate by Chinese population; ASIRW, age standardized incidence rate by world population.

Table 5 Age-specific mortality of lung cancer in cancer registration areas in 2009 ($1/10^5$)

Age group	All areas			Urban			Rural		
	Both	Male	Female	Both	Male	Female	Both	Male	Female
All	45.57	61.00	29.77	50.32	67.11	33.24	35.81	48.58	22.56
0–	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1–	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5–	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10–	0.04	0.08	0.00	0.04	0.07	0.00	0.05	0.10	0.00
15–	0.09	0.04	0.15	0.09	0.00	0.17	0.11	0.10	0.11
20–	0.27	0.37	0.17	0.27	0.37	0.16	0.28	0.37	0.19
25–	0.58	0.65	0.51	0.36	0.39	0.33	1.08	1.24	0.91
30–	1.43	1.73	1.12	1.31	1.44	1.18	1.65	2.26	1.03
35–	3.59	3.88	3.29	3.63	3.92	3.33	3.51	3.80	3.21
40–	9.73	12.60	6.79	9.22	12.17	6.21	10.75	13.46	7.97
45–	18.27	24.52	11.80	19.04	25.42	12.38	16.56	22.45	10.50
50–	38.77	54.39	22.67	38.86	55.81	21.46	38.56	50.79	25.77
55–	63.38	91.32	35.26	63.02	93.52	32.86	64.26	86.22	41.18
60–	99.76	142.14	57.24	98.17	141.23	55.99	103.20	144.05	60.05
65–	158.45	231.06	87.55	168.72	246.42	94.95	138.01	201.72	72.17
70–	268.29	370.06	174.74	283.93	386.39	191.37	230.68	331.97	133.64
75–	372.20	530.35	231.68	402.54	563.67	257.99	293.41	442.23	164.42
80–	431.21	619.54	281.74	478.02	677.90	315.50	312.80	464.62	199.48
85–	382.35	602.55	243.00	439.01	684.16	279.89	234.54	377.22	150.05

80–84 years, except in urban men, where the mortality of patients over 85 years of age was higher than in other groups. For those aged under 60, age specific mortalities were higher in rural areas, however, for those aged 60 and over, mortalities in urban areas went beyond those in rural, both in men and women.

Discussion

In 2012, the NCCR started to collect data for calendar year 2009 from local registries based on the requirement of Cancer Registration Programs. After comprehensive quality evaluation, 72 registries were qualified as sources for the annual report to reflect the cancer burden in 2009. The data in this report covered 85.47 million people from 31 urban areas (about 57.49 million), the largest population coverage to date. We analyzed lung cancer cases, including 45 784 diagnosed new patients and 38 946 deaths, which provided a good representation for the whole country; however, further analysis should be conducted.

The results show that lung cancer was the most common cancer for men in all areas, particularly urban areas, and second in women to breast cancer, especially in urban areas. Lung cancer was the leading cause of cancer death in all groups stratified by gender and area. Ages over 50 were the high-risk age groups because of the increase of incidence and mortality rates accompanied by increasing age. This study provides updated burden information on lung cancer in 2009 for China, broadly used for making anti-cancer policy and research on lung cancer.

The Ministry of Health approved the “National Program of Cancer Registry” in 2008, providing financial support to establish cancer registries in each province. The number of cancer registries has dramatically increased from 43 in 2008, to 222 in 2012, with the covered population reaching 200 million. We estimate that by the end of 2015, there will be more than 300 registries covering 20% of the national population. However, it is the quality of cancer registration data that is the key issue in these programs.

Compared to the cancer incidence and mortality rates of 2008, we found the crude incidence and mortality rates were slightly lower in 2009, but after adjustment by age, they remained stable, reflecting both a different age structure in the coverage population, and reliable sources.⁷ The recent trend analysis done by NCCR using 10 years of lung cancer data has shown that the lung cancer burden has been getting worse.⁸ Chen *et al.* reported the incidence of new cases in China were about 500 000 in 2005⁹ and would reach 700 000 in 2020.³

NCCR is the authoritative source of information on cancer incidence and mortality in China. NCCR collects and publishes these statistics from population-based registries. The population coverage is increasing year by year. Since 2009, the

Ministry of Health helped to create more cancer registries and provided specific funding to support the development of cancer surveillance. By the end of 2012, there were 222 cancer registries around China, covering 14% of the whole population. However, the new cancer registries need at least five years to ensure data quality and reliability.

NCCR has evaluated the representation of cancer registries' data compared with the national death survey and found that urban registries produced representative data, but that data has been overestimated in rural areas.¹⁰ With an increase in the number of registries created, data will become more representative. However, the data should be constantly re-evaluated. The data provided is the most up-to-date statistics of lung cancer incidence and mortality available, which is used to inform policy makers, researchers, and public health workers.

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Disclosure

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