Incidence of Cancers Associated with Overweight and Obesity – Idaho, 2007–2016

Executive Summary

Christopher J. Johnson, MPH[1], Charlene Cariou, MHS, CHES[2], Ivie Smart, MHE[2], Kara Mastalski, MA[2]

Background

Overweight and obesity are associated with increased risk of at least 13 different types of cancer. In October 2017, the Centers for Disease Control and Prevention published a study in the Morbidity and Mortality Weekly Report on trends in the incidence of cancers associated with overweight and obesity in the United States. In this report, overweight- and obesity-related cancers were defined as those classified by the International Agency for Research on Cancer as having sufficient evidence for an association with excess body fatness. Not all of the cancers in these sites are caused by excess body weight; many are attributable to other known risk factors, such as smoking. Obesity is more strongly associated with some of these cancer types than others. The American Cancer Society has estimated that 7.8% of cancers in the United States are attributable to excess body weight. This report replicates the analysis using data for Idaho residents.

Methods

Data from the Cancer Data Registry of Idaho for 2012-2016 were used to assess incidence rates, and data from 2007 to 2016 were used to assess trends for cancers associated with overweight and obesity (see figure) by sex, age, race/ethnicity, health district and county, area-based socioeconomic position, and cancer site. Because

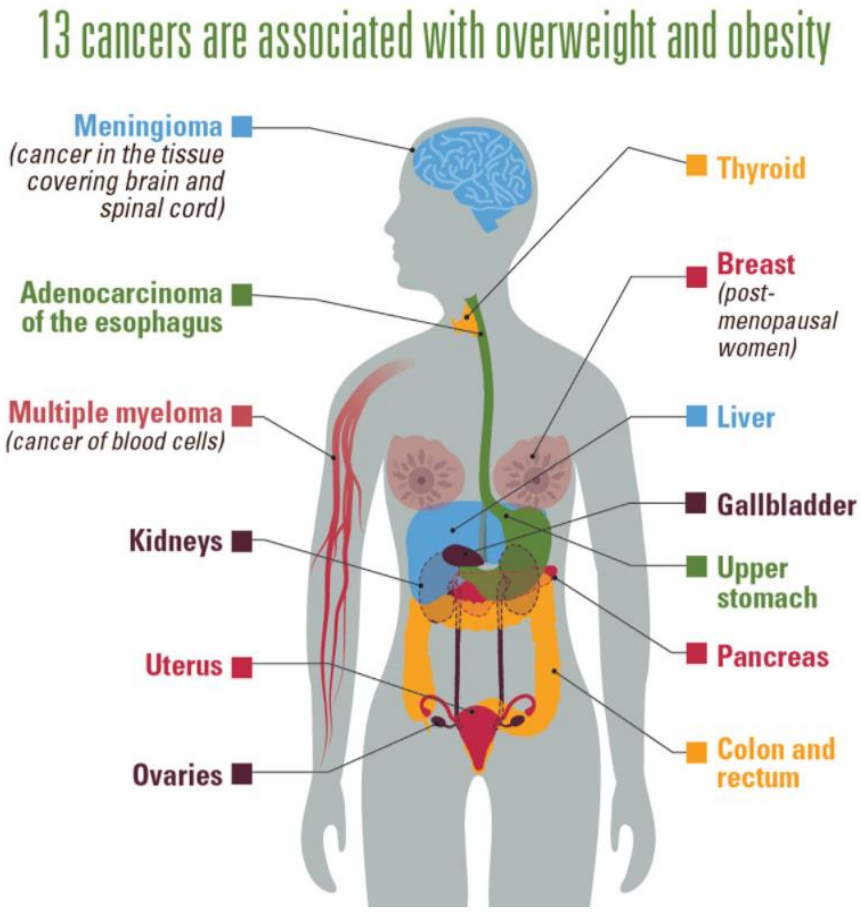


Figure: CDC Vital Signs October 2017

[1] Cancer Data Registry of Idaho
[2] Idaho Department of Health and Welfare

15,922

Idahoans diagnosed with an overweight- or obesity-related cancer

41%

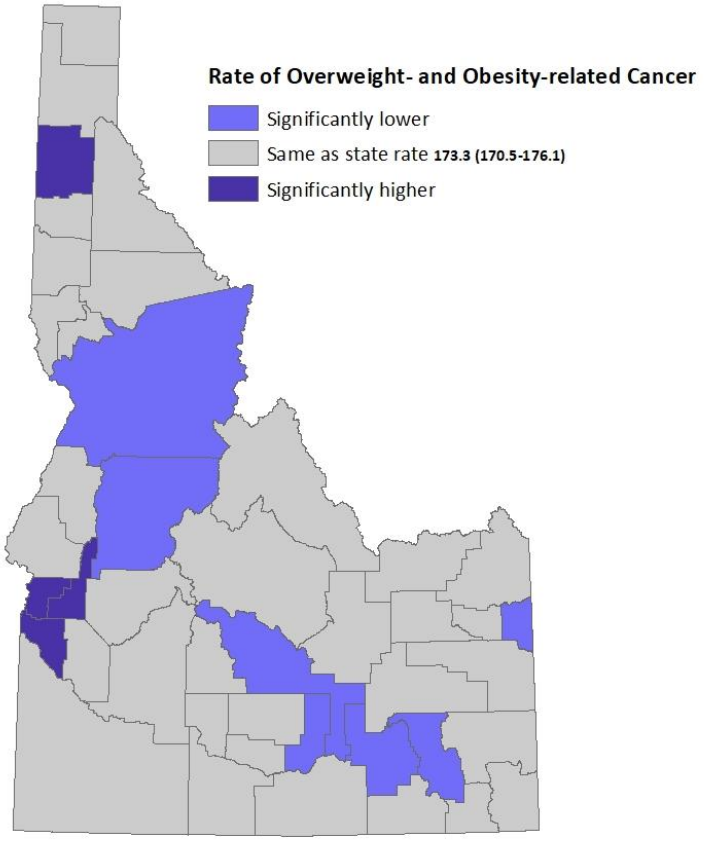
of cancers diagnosed in Idaho are overweight- or obesity-related

57% of cancers diagnosed in **women** are overweight- or obesity-related

25% of cancers diagnosed in **men** are overweight- or obesity-related

screening for colorectal cancer can reduce colorectal cancer incidence through detection of precancerous polyps before they become cancerous, trends with and without colorectal cancer were analyzed.

Average Annual Age-Adjusted Rate of Overweight- and Obesity-Related Cancer Cases, by County 2012-2016



Results

From 2012-2016, 15,922 Idaho residents received a diagnosis of a cancer associated with overweight and obesity, representing 41% of all cancers diagnosed. Overweight- and obesity-related cancer incidence rates were higher among older persons (ages ≥50 years) than younger persons; higher among females than males; and higher among non-Hispanic whites and American Indian/Alaska Natives compared with other groups. Incidence rates for overweight- and obesity-related cancers during 2012–2016 varied by geographic area and area-based socioeconomic position. Among Idaho's 44 counties, seven (Bannock, Blaine, Idaho, Minidoka, Power, Teton, Valley) had significantly lower rates of overweight- and obesity-related cancer incidence than the state of Idaho and four (Canyon, Gem, Kootenai, Payette) had significantly higher rates. Trends in incidence rates for overweight- and obesity-related cancers during 2007–2016 varied by sex and cancer site.

Conclusions

The burden of overweight- and obesity-related cancer is high in Idaho. Incidence rates of overweight- and obesity-related cancers (except colorectal cancer) have increased among male Idahoans while trends for other cancers are decreasing.

Implications for Public Health Practice

The burden of overweight- and obesity-related cancers might be reduced through efforts to prevent and control overweight and obesity. Comprehensive cancer control strategies, including use of evidence- based interventions to promote healthy weight, could help decrease the incidence of these cancers in Idaho.

IDAHO DEPARTMENT OF HEALTH & WELFARE
DIVISION OF PUBLIC HEALTH

COMPREHENSIVE CANCER CONTROL OF IDAHO

IPAN Idaho Physical Activity and Nutrition Program

CDRI Cancer Data Registry of Idaho

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Authors
Christopher J. Johnson, MPH, Cancer Data Registry of Idaho
Charlene Cariou, MHS, CHES, Idaho Department of Health and Welfare
Ivie Smart, MHE, Idaho Department of Health and Welfare
Kara Mastalski, MA, Idaho Department of Health and Welfare

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Abstract
Background
Overweight and obesity are associated with increased risk of at least 13 different types of cancer. In October 2017, the Centers for Disease Control and Prevention published a study in the Morbidity and Mortality Weekly Report on trends in the incidence of cancers associated with overweight and obesity in the United States. This report replicates the analysis using data for Idaho residents.
Methods
Data from the Cancer Data Registry of Idaho for 2012-2016 were used to assess incidence rates, and data from 2007 to 2016 were used to assess trends for cancers associated with overweight and obesity (adenocarcinoma of the esophagus; cancers of the breast [in postmenopausal women], colon and rectum, endometrium, gallbladder, gastric cardia, kidney, liver, ovary, pancreas, and thyroid; meningioma; and multiple myeloma) by sex, age, race/ethnicity, health district and county, area-based socioeconomic position, and cancer site. Because screening for colorectal cancer can reduce colorectal cancer incidence through detection of precancerous polyps before they become cancerous, trends with and without colorectal cancer were analyzed.
Results
From 2012-2016, 15,922 Idaho residents received a diagnosis of a cancer associated with overweight and obesity, representing 41% of all cancers diagnosed. Overweight- and obesity-related cancer incidence rates were higher among older persons (ages ≥50 years) than younger persons; higher among females than males; and higher among non-Hispanic whites and American Indian/Alaska Natives compared with other groups. Incidence rates for overweight- and obesity-related cancers during 2012–2016 varied by geographic area and area-based socioeconomic position. Trends in incidence rates for overweight- and obesity-related cancers during 2007–2016 varied by sex and cancer site.
Conclusions
The burden of overweight- and obesity-related cancer is high in Idaho. Incidence rates of overweight- and obesity-related cancers (except colorectal cancer) have increased among male Idahoans while trends for other cancers are decreasing.

Implications for Public Health Practice

The burden of overweight- and obesity-related cancers might be reduced through efforts to prevent and control overweight and obesity. Comprehensive cancer control strategies, including use of evidence-based interventions to promote healthy weight, could help decrease the incidence of these cancers in Idaho.

Key Points

- Overweight and obesity are associated with increased risk of at least 13 different types of cancer.
- Overweight- and obesity-related cancers accounted for 41% of all cancers diagnosed in 2012-2016.
- About 57% of cancers diagnosed in women and 25% of those diagnosed in men are overweight- and obesity- related cancers.
- The incidence of overweight- and obesity-related cancers (excluding colorectal cancer) increased significantly among male Idahoans during 2007–2016.
- There are significant disparities in the burden of overweight- and obesity-related cancers by geographic area and socioeconomic position.
- The findings emphasize the importance of intensifying efforts to prevent and treat overweight and obesity.
- Multilevel approaches to comprehensive cancer control that address social determinants of health and include evidence-based interventions that address healthy weight and other cancer risk factors might help reduce the burden of cancer and other chronic diseases.

Introduction

In 2016, 27.4% of adult Idahoans had obesity (body mass index [BMI] ≥30 kg/m^2) and an additional 37.1% were overweight (BMI 25.0–29.9 kg/m^2).[3] Approximately half of U.S. residents are unaware that adults who are overweight or have obesity are at increased risk for cancer.[4] [5] The International Agency for Research on Cancer (IARC) states that there is sufficient evidence for an association with excess body fatness, including overweight, obesity, and weight gain, and at least 13 cancers.[3] These cancers include adenocarcinoma of the esophagus; cancers of the breast (in postmenopausal women), colon and rectum, endometrium (corpus uterus), gallbladder, gastric cardia, kidney (renal cell), liver, ovary, pancreas, and thyroid; meningioma, and multiple myeloma. Overweight and obesity might increase cancer risk through induction of metabolic and endocrine abnormalities, including increases in inflammation and levels of insulin, insulin-like growth factor, and sex hormones.[6] In October 2017, the Centers for Disease Control and Prevention (CDC) published a study in the Morbidity and Mortality Weekly Report (MMWR) on trends in the incidence of cancers associated with overweight and obesity in the United States.[7] The current report replicates the CDC analysis using data for Idaho residents and uses the MMWR language as a template. Data from the Cancer Data Registry of Idaho were used to calculate incidence rates for 2012-2016 and trends during 2007–2016 for cancers associated with overweight and obesity (overweight- and obesity-related cancers). In this report, overweight- and obesity-related cancers were defined as those classified by IARC as having sufficient evidence for an association with excess body fatness. Not all of the cancers in these sites are caused by excess body weight; many are attributable to other known risk factors, such as smoking. Obesity is more strongly associated with some of these cancer types than others. The American Cancer Society has estimated that 7.8% of cancers in the United States are attributable to excess body weight.[8]

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[4] American Institute for Cancer Research. The AICR 2015 cancer risk survey report. Washington, DC: American Institute for Cancer Research;
2015. http://www.aicr.org/assets/docs/pdf/education/aicr-awareness- report-2015.pdf

[5] Lauby-Secretan B, Scoccianti C, Loomis D, Grosse Y, Bianchini F, Straif K; International Agency for Research on Cancer Handbook Working Group. Body fatness and cancer—viewpoint of the IARC Working Group. N Engl J Med 2016;375:794–8. https://doi. org/10.1056/NEJMsr1606602

[6] Renehan AG, Zwahlen M, Egger M. Adiposity and cancer risk: new mechanistic insights from epidemiology. Nat Rev Cancer 2015;15:484–98. https://doi.org/10.1038/nrc3967

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[8] Islami F, Goding Sauer A, Miller KD, Siegel RL, Fedewa SA, Jacobs EJ, McCullough ML, Patel AV, Ma J, Soerjomataram I, Flanders WD, Brawley OW, Gapstur SM, Jemal A13. Proportion and number of cancer cases and deaths attributable to potentially modifiable risk factors in the United States. CA Cancer J Clin. 2018 Jan;68(1):31-54. doi: 10.3322/caac.21440. Epub 2017 Nov 21.

Methods

Cancer incidence data

Counts of incident cancer cases by primary site, census tract, age group at diagnosis, sex, and race/ethnicity were obtained from the Cancer Data Registry of Idaho (CDRI) for the period 2007-2016. CDRI data are geocoded to support statistical analysis at the census tract and coarser levels of geographic detail. To geocode case data, CDRI used the Automated Geospatial Geocoding Interface Environment (AGGIE) System, developed under a partnership between the North American Association of Central Cancer Registries, Texas A&M University, and the National Cancer Institute to provide a single, uniform geocoding platform for open use by U.S. cancer registries.[9] [10] Cancer site for cases was classified by anatomic site and histology using the International Classification of Diseases for Oncology, Third Edition (http://codes.iarc.fr/) and cases with hematopoietic histologies were classified using the World Health Organization Classification of Tumours of Haematopoietic and Lymphoid Tissues, Fourth Edition (http://www.bloodjournal.org/content/117/19/5019?sso-checked=true#T1). Besides for meningiomas, only cases of invasive cancer were included. For meningiomas, benign and borderline behavior cases were also included, as these constitute the majority from this site. Postmenopausal breast cancer was defined as breast cancer diagnosed in women aged ≥50 years.

Population estimates

Annual population counts by census tract, age, race/ethnicity, and sex are not available from the U.S. Census Bureau Population Estimates Program[11], so we estimated them. Starting with population counts by census tract, age, race/ethnicity, and sex that are available for the 2010 decennial census and annual county-level population estimates from the U.S. National Center for Health Statistics for 2007-2016,[12] [13] we used iterative proportional fitting to allocate county population counts to tract by age, sex, and race/ethnicity. Because this approach does not allow for differential growth over time by census tract within county, we supplemented this approach with data from serial time series from U.S. Census Bureau American Community Survey 5-year estimates (table B01001) covering 2007-2011 through 2012-2016. For two broad age groups, 0-39, and 40+, we performed linear regression on the natural log of the American Community Survey census tract population estimates to estimate annual percent change (APC). The APC estimates were used to allow differential trajectories, by broad age group, of census

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[9] Goldberg, D. W., Kohler, B., Kosary, C. (year). The Texas A&M, NAACCR, NCI Geocoding Service. Available online at http://geo.naaccr.org.

[10] Goldberg, D. W., Cockburn, M. G. (2010). Improving geocode accuracy with candidate selection criteria. Transactions in GIS. Vol. 14 (S1), pp. 129-146. Available online at http://onlinelibrary.wiley.com/doi/10.1111/j.1467-9671.2010.01211.x/abstract.

[11] https://factfinder.census.gov/faces/nav/jsf/pages/programs.xhtml?program=pep

[12] National Center for Health Statistics. Bridged-race intercensal estimates of the resident population of the United States for July 1, 2000-July 1, 2009, by year, county, single-year of age (0, 1, 2, .., 85 years and over), bridged race, Hispanic origin, and sex. Prepared under a collaborative arrangement with the U.S. Census Bureau. Available from: /nchs/nvss/bridged_race.htm as of June 28, 2008, following release by the U.S. Census Bureau of the revised unbridged postcensal estimates by 5-year age group on June 23, 2016.

[13] National Center for Health Statistics. Vintage 2016 postcensal estimates of the resident population of the United States (April 1, 2010, July 1, 2010-July 1, 2016), by year, county, single-year of age (0, 1, 2, .., 85 years and over), bridged race, Hispanic origin, and sex. Prepared under a collaborative arrangement with the U.S. Census Bureau. Available from: /nchs/nvss/bridged_race.htm as of June 26, 2017, following release by the U.S. Census Bureau of the unbridged Vintage 2016 postcensal estimates by 5-year age group on June 22, 2017.

tract populations within each county. The census 2010 tract proportions were used directly for 2007-2010 because there was less population growth during the U.S. Great Recession. For 2011-2016, we used the tract-level APC trajectories constrained by the county-level population totals. The resultant population estimates have the characteristics of summing to the annual county-level population estimates from the U.S. National Center for Health Statistics, having the same tract-level proportions within county for 2007-2010, and allowing differential growth for 2011-2016.

Prevalence of normal weight

For determining the prevalence of normal weight (BMI 18.5–24.9 kg/m^2) in Idaho counties, we used data collected by the Bureau of Vital Records and Health Statistics (BVRHS), Division of Public Health, Idaho Department of Health and Welfare, under a cooperative agreement with the Centers for Disease Control and Prevention. These Behavioral Risk Factor Surveillance System (BRFSS) data are collected annually using a telephone survey that employs random sampling methods to measure population prevalence of risk factors for the major causes of death.[14] County-level estimates of the proportion of the population with normal weight for the period 2013-2016 were calculated by CDRI. Analysis weights were poststratified to 2016 population estimates by age group, sex, and county, beginning with the BRFSS raked weights. A minimum of 50 respondents was required to generate county-level statistics.

Census tract-based socioeconomic position

Using 5-year estimates from the American Community Survey, census tracts were assigned categories of socioeconomic position variables (proportion of persons with incomes below federal poverty guidelines [table S1701, 2007-2011], educational attainment among persons aged 25 years and older [table S1501, 2007-2011], and health insurance coverage status among the civilian noninstitutionalized population aged 18-64 [table B27001, 2008-2012].[15] Time periods for 5-year estimates were selected to coincide with the earliest incidence data used in this report for the poverty and educational attainment measures. For the health insurance measure, the latest 5-year data prior to impacts of the Affordable Care Act were used. Counts of cases and populations were aggregated over categories of socioeconomic position variables to calculate incidence rates by census tract-based socioeconomic position.

Statistical analysis

Incidence rates and rate ratios were calculated using SEER*Stat.[16] Rates were estimated by sex, age, race/ethnicity, health district/county, and census tract-based socioeconomic position. Incidence rates are per 100,000 and age-adjusted to the 2000 US Standard Population (19 age groups - Census P25-1130) standard. Rates presented by age group are not age-adjusted. Ninety-five percent confidence

[14] http://www.healthandwelfare.idaho.gov/Health/VitalRecordsandHealthStatistics/HealthStatistics/BehavioralRiskFactorSurveillanceSystem/tabid/913/Default.aspx

[15] U.S. Census Bureau, American Community Survey 5-Year Estimates

[16] Surveillance Research Program, National Cancer Institute SEER*Stat software (www.seer.cancer.gov/seerstat) version 8.3.4.

intervals for rates[17] are presented to allow for informal comparisons among rates, without specifying a referent group. For characteristics besides age, rate ratios are also presented and p-values <0.05 are noted for comparisons to the referent group. Joinpoint regression (https://surveillance.cancer.gov/joinpoint) was used to calculate changes in rates by cancer site and sex; trends were quantified by average annual percent change. Because screening for colorectal cancer can reduce colorectal cancer incidence through detection of precancerous polyps before they become cancerous (https://www.uspreventiveservicestaskforce.org/Page/Document/UpdateSummaryFinal/colorectal-cancer-screening2?ds), trends with and without colorectal cancer were analyzed.

Results

During 2012-2016, 15,922 Idahoans received a diagnosis of an overweight- or obesity-related cancer (Table 1). This represents 41% of the nearly 39,000 cancers diagnosed 2012-2016 (57% of the 19,453 cancers among women and 25% of the 19,537 cancers among males). Overweight- and obesity-related cancer incidence rates were higher among older persons (ages ≥50 years) than younger persons. The overweight- and obesity-related cancer incidence rate was higher among females (230.1 per 100,000 population) than among males (112.7 per 100,000), partially because endometrial, ovarian, and postmenopausal female breast cancers accounted for 41% (6,528) of overweight- and obesity-related cancers. Incidence rates varied by race/ ethnicity, with higher incidence among non-Hispanic whites and American Indian/Alaska Natives compared with other groups. Significant differences in overweight- and obesity-related cancer incidence rates by race/ethnicity were limited to females, with Hispanics and Asian or Pacific Islanders having significantly lower rates.

There were monotonic increases in overweight- and obesity-related cancer incidence rates by census tract-based poverty, with persons living in census tracts with a higher proportion of persons with incomes below federal poverty guidelines having the highest incidence rates (Table 1). This relationship was driven by rates among males. Among males living in census tracts with >= 20% of the population with incomes below federal poverty guidelines, incidence rates of overweight- and obesity-related cancer were almost 20% higher than in census tracts with <5% of the population with incomes below federal poverty guidelines. A similar relationship was observed for census-tract based educational attainment; males living in census tracts with <30% of the population aged 25 and older with college degrees had significantly higher incidence rates of overweight- and obesity-related cancer than males living in census tracts with >= 40% with college degrees. There were significant monotonic increases in overweight- and obesity-related cancer incidence rates by census tract-based uninsured among males; males living in census tracts with >= 35% of the 18-64 year old population uninsured had incidence rates of overweight- and obesity-related cancer 16% higher than in census tracts with <15% of the population uninsured.

There were significant differences in overweight- and obesity-related cancer incidence rates by public health district and county (Table 2). During 2012-2016, Health Districts 1 and 3 had significantly higher rates than the state of Idaho and Health Districts 5 and 6 had significantly lower rates. Among Idaho's 44

[17] Tiwari RC, Clegg LX, Zou Z. Efficient interval estimation for age-adjusted cancer rates. Stat Methods Med Res 2006 Dec;15(6):547-69.

counties, seven (Bannock, Blaine, Idaho, Minidoka, Power, Teton, Valley) had significantly lower rates of overweight- and obesity-related cancer incidence than the state of Idaho and four (Canyon, Gem, Kootenai, Payette) had significantly higher rates. By county, the prevalence of normal weight ranged from 21% in Gem County to 47% in Blaine County. County-level prevalence of normal weight was significantly correlated with the incidence rate of overweight- and obesity-related cancer (Pearson's r = -0.43, p=0.004).

Among cancers affecting both males and females, incidence rates in 2012-2016 were higher among males than among females for colorectal cancer (38.9 per 100,000 versus 32.0 per 100,000), kidney cancer (19.6 versus 10.5), pancreatic cancer (15.1 versus 11.3), liver cancer (8.7 versus 2.8), adenocarcinoma of the esophagus (6.2 versus 0.7), multiple myeloma (7.3 versus 4.5), and gastric cardia cancer (3.8 versus 1.0) (Table 3). Females had higher rates than males of thyroid cancer (24.3 versus 7.5) and rates were similar among males and females for gallbladder cancer (1.0 versus 0.9). Among the three overweight- and obesity-related cancers that affect females only, incidence rates were higher for postmenopausal breast cancer (343.6 per 100,000, restricted to ages 50+) than for endometrial cancer (25.3 per 100,000) and ovarian cancer (11.2 per 100,000).

By primary site, incidence rates decreased significantly over the period 2007-2016 for colorectal cancer (-2.2% per year) and ovarian cancer (-2.7%). Incidence rates increased significantly over the period 2007-2016 for liver cancer (4.4%) and pancreatic cancer (2.0%). The incidence rates were stable for the remainder of the primary sites we studied. For all overweight- and obesity-related cancers combined, there was no significant trend from 2007-2016 for males or females. Increased use of colorectal cancer screening tests likely contributed to the decline in colorectal cancer; when colorectal cancer was excluded from overweight- and obesity-related cancers, a 1.1% annual increase in incidence was observed among males. For the same time period, there were significant declines in the annual incidence rates of cancers not related to overweight and obesity, overall (-1.9%) and for males (-3.1%). The increase in risk for cancer per 1 kg/m^2 increase in BMI ranged from 1% each for thyroid and ovarian cancers to 9% for adenocarcinoma of the esophagus.

Discussion

Overweight- and obesity-related cancers accounted for 41% of all cancers diagnosed in 2012-2016 and varied substantially across demographic groups. Endometrial, ovarian, and postmenopausal female breast cancers accounted for 41% of new cases of overweight-and obesity-related cancers in 2012-2016, which is reflected in the higher overall incidence of overweight- and obesity-related cancers among females. For overweight- and obesity-related cancers that occurred among both males and females, however, the incidence of most cancers was higher in males. The largest significant increases in incidence rates from 2007-2016 were for liver and pancreatic cancers. The largest significant decrease was for ovarian cancer. The second largest decline was in the rate of colorectal cancer, which accounted for 21% of overweight- and obesity-related cancers; this trend influenced the overall trend in the incidence of overweight- and obesity-related cancers during 2007–2016. There has been an increase in colorectal cancer screening over time in Idaho,[1] which might have contributed to the decline in colorectal cancer incidence through detection of precancerous polyps, which can then be removed before becoming cancerous. When colorectal cancer was excluded from the trend analysis, overweight-

and obesity-related cancer incidence increased significantly among males. The increase in overweight- and obesity-related cancer incidence coincides with an increase in the prevalence of overweight and obesity in Idaho.[1] These historical and current trends in overweight and obesity and cancers related to excess weight reflect the continued need for public health strategies to prevent and control overweight and obesity in children and adults and help communities make it easier for people to be physically active and eat healthfully.

There is consistent evidence that a high BMI is associated with cancer risk. Persons who are overweight or have obesity are nearly twice as likely as are healthy-weight (BMI = 18.5–24.9 kg/m^2) persons to develop adenocarcinoma of the esophagus and cancers of the gastric cardia, liver, and kidney.[18] [19] [20] [21] Persons who have obesity are approximately 30% more likely to develop colorectal cancer than are persons with healthy weight.[22] Women who are overweight or have obesity are approximately two to four times as likely as are women with healthy weight to develop endometrial cancer.[23] Observational studies have provided evidence that even a 5-kg (11 pound) increase in weight since early adulthood is associated with increased risk for overweight- and obesity- related cancers.[24] Maintaining a healthy weight throughout life has been associated with a reduction in risk of these cancers.[3] However, the population effect of weight loss interventions on cancer risk might not be observable for at least a decade.[4] In studies evaluating the effect of weight change on risks for endometrial cancer and breast cancer after long-term follow-up, weight loss was associated with reduced risks for both types of cancer among postmenopausal women.[25] [26]

Incidence rates for the latter time periods for both males and females are largely similar between the current and MMWR publications. There is a notable difference in the published incidence rates for postmenopausal female breast cancer because the current publication uses the same age range for

[18] Hoyo C, Cook MB, Kamangar F, et al. Body mass index in relation to oesophageal and oesophagogastric junction adenocarcinomas: a pooled analysis from the International BEACON Consortium. Int J Epidemiol 2012;41:1706–18. https://doi.org/10.1093/ije/dys176

[19] Chen Y, Liu L, Wang X, et al. Body mass index and risk of gastric cancer: a meta-analysis of a population with more than ten million from 24 prospective studies. Cancer Epidemiol Biomarkers Prev 2013;22:1395–408. https://doi.org/10.1158/1055-9965.EPI-13-0042

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[21] Wang F, Xu Y. Body mass index and risk of renal cell cancer: a dose- response meta-analysis of published cohort studies. Int J Cancer 2014;135:1673–86. https://doi.org/10.1002/ijc.28813

[22] Ma Y, Yang Y, Wang F, et al. Obesity and risk of colorectal cancer: a systematic review of prospective studies. PLoS One 2013;8:e53916. https://doi.org/10.1371/journal.pone.0053916

[23] Setiawan VW, Yang HP, Pike MC, et al.; Australian National Endometrial Cancer Study Group. Type I and II endometrial cancers: have they different risk factors? J Clin Oncol 2013;31:2607–18. https://doi. org/10.1200/JCO.2012.48.2596

[24] Keum N, Greenwood DC, Lee DH, et al. Adult weight gain and adiposity-related cancers: a dose-response meta-analysis of prospective observational studies. J Natl Cancer Inst 2015;107:djv088. https://doi. org/10.1093/jnci/djv088

[25] Luo J, Chlebowski RT, Hendryx M, et al. Intentional weight loss and endometrial cancer risk. J Clin Oncol 2017;35:1189–93. https://doi. org/10.1200/JCO.2016.70.5822

[26] Eliassen AH, Colditz GA, Rosner B, Willett WC, Hankinson SE. Adult weight change and risk of postmenopausal breast cancer. JAMA
2006;296:193–201. https://doi.org/10.1001/jama.296.2.193

counting cases and population (50+) and the MMWR publication restricted the numerator to 50+ but used the denominator for all ages. There is also a notable difference for meningioma because the current publication includes benign and borderline behavior cases, which are the majority of meningiomas, and the MMWR publication restricted all analyses to invasive cases only.

By primary site, there was a similar pattern to the overall overweight- and obesity-related cancer relationship with census tract-based socioeconomic position for males, with generally higher incidence rates among lower socioeconomic position census tracts for cancers of the colon & rectum, kidney, liver, gastric cardia, gallbladder, adenocarcinoma of the esophagus, and meningioma (data not shown). Among females, there were generally higher incidence rates among lower socioeconomic position census tracts for colorectal, kidney, endometrium, pancreas, and liver cancers. The opposite relationship was observed for breast and thyroid cancers and multiple myeloma, effectively cancelling out the relationship for all overweight- and obesity-related cancers combined among females.

Three counties with reputations for active outdoor lifestyles (Blaine, Teton, and Valley) were among the six counties with lowest incidence rates of overweight- and obesity-related cancer and had the highest estimated prevalence of normal weight among adults. Gem County had the highest incidence rate of overweight- and obesity-related cancer and the lowest estimated prevalence of normal weight among adults.

Without intensified nationwide efforts to prevent and treat overweight and obesity, the high prevalence of excess weight might impede further declines in overall cancer incidence.[27] These efforts include investing in addressing both social and behavioral determinants of health, such as unemployment and disparities in education and housing, to achieve better population health (https://nam.edu/addressing-social- determinants-of-health-and-health-disparities-a-vital-direction-for-health-and-health-care/). Eating a healthy diet and engaging in sufficient physical activity are important components of behavioral strategies to maintain a healthy weight. Population-based strategies to prevent and reduce overweight and obesity include helping persons of all ages meet dietary (https://health.gov/dietaryguidelines/2015/guidelines) and physical activity (https://health.gov/PAGuidelines) guidelines by supporting healthy eating and active living in a variety of settings, including communities, worksites, schools, and early care and education facilities. Strategies to provide support for these settings have been recommended by a number of public health entities including CDC (https://www.cdc.gov/mmwr/ preview/mmwrhtml/rr5807a1.htm), the National Academy of Medicine,[28] and the Community Preventive Services Task Force (https://www.thecommunityguide.org/topic/ obesity). Health care providers could encourage patients to maintain healthy weights throughout their lifespans. To help treat obesity, the U.S. Preventive Services Task Force recommends that clinicians screen all adults for obesity and either offer patients who have obesity intensive, multicomponent behavioral interventions or refer them to programs that offer these services

[27] Eheman C, Henley SJ, Ballard-Barbash R, et al. Annual report to the nation on the status of cancer, 1975–2008, featuring cancers associated with excess weight and lack of sufficient physical activity. Cancer 2012;118:2338–66. https://doi.org/10.1002/cncr.27514

[28] Institute of Medicine. Accelerating progress in obesity prevention: solving the weight of the nation. Washington, DC: National Academies Press; 2012.

(https://www.uspreventiveservicestaskforce.org/Page/Document/UpdateSummaryFinal/obesity-in-adults- screening-and-management); similar recommendations exist for children aged ≥6 years (https://www.uspreventiveser- vicestaskforce.org/Page/Document/UpdateSummaryFinal/obesity-in-children-and-adolescents-screening).

The CDC's National Comprehensive Cancer Control Program supports comprehensive cancer control efforts in all 50 states, DC, eight tribes and tribal organizations, and seven U.S. territories and Pacific Island jurisdictions; these efforts include policy, systems, and environmental changes that promote physical activity and healthy food options in communities. The Idaho Comprehensive Cancer Plan 2016 - 2020 includes goals and strategies related to nutrition and physical activity to reduce cancer risk.[29] Other CDC-funded programs, such as the Idaho Physical Activity and Nutrition Program, address nutrition, physical activity, and obesity in childcare settings, schools, worksites, and the community environment. Maintaining and strengthening these programmatic activities might help reduce the burden of overweight- and obesity-related cancer.

The findings in this report are subject to at least five limitations. First, the weights and BMI histories of cancer patients were not known. Second, because race and ethnicity data are abstracted from medical records, they are subject to misclassification (https://www.cdc.gov/cancer/npcr/uscs/technical_notes/interpreting/race.htm). Third, whereas IARC's most recent report was used to define overweight- and obesity-related cancer, this might underestimate the actual burden, because evidence is still accumulating related to the association of overweight and obesity with other cancers.[3] Fourth, many different risk factors might contribute to development of over- weight- and obesity-related cancers, such as genetic mutations; chronic infections; and tobacco, hormone, and alcohol use.[2] Changes in these other risks, as well as in cancer screening rates, might have affected the number of cancer cases and the trends described in this report. Finally, although this report tracks overweight- and obesity-related cancers, it does not estimate what proportion of these cancers are attributable to overweight and obesity. Subsequent to the publication of the MMWR report on overweight- and obesity-related cancers, there were numerous misleading news stories that confused the proportion of cancers *related to* and *attributable to* excess weight. The American Cancer Society contributed a blog entry to clarify the issue and shortly thereafter published an article on population-attributable fractions (PAF) of cancers due to major risk factors, including smoking, excess weight, and alcohol use.[30] It is hoped that a methodology for estimating PAFs at the state and local level will be made available by CDC for future use in reports of cancers attributable to excess weight.

The incidence of overweight- and obesity-related cancers (excluding colorectal cancer) increased significantly among males during 2007–2016, mirroring long-term increases in obesity.[1] Multilevel approaches to comprehensive cancer control that address social determinants of health and include evidence-based interventions that address healthy weight and other cancer risk factors might help reduce the burden of cancer and other chronic diseases in Idaho.

[29] http://www.ccaidaho.org/CCAI%20Strategic%20Plan-FINAL_Jan%20222015.pdf
[30] https://acspressroom.wordpress.com/2017/10/03/behind-the-numbers-cancers-associated-with-obesity/

Table 1. Number and average annual age-adjusted rate of overweight- and obesity-related cancer cases, by selected characteristics -- Idaho, 2012-2016.

	Total						Male						Female					
Characteristic	Cases	Rate	Lower CI	Upper CI	Rate Ratio		Cases	Rate	Lower CI	Upper CI	Rate Ratio		Rate	Lower CI	Upper CI		Rate Ratio	
Total	15,922	173.3	170.5	176.1			4,904	112.7	109.5	116.0			11,018	230.1	225.7	234.6		
Age group (years)																		
<20	66	2.8	2.1	3.5			24	2.0	1.3	2.9			42	3.6	2.6	4.9		
20-49	1,523	48.9	46.5	51.4			483	30.5	27.8	33.3			1,040	67.9	63.9	72.2		
50-64	5,696	375.5	365.9	385.4			1,589	212.8	202.4	223.5			4,107	533.5	517.3	550.0		
65-74	4,631	667.9	648.8	687.4			1,520	446.1	424.0	469.1			3,111	882.2	851.4	913.7		
75+	4,006	845.3	819.3	871.9			1,288	619.0	585.6	653.7			2,718	1022.5	984.4	1061.7		
Race/Ethnicity																		
Non-Hispanic White	14,651	173.3	170.4	176.2	-		4,489	112.0	108.6	115.4	-		10,162	230.7	226.1	235.3	-	
Hispanic (any race)	714	146.3	134.5	158.8	0.84	#	240	105.8	91.0	122.2	0.95		474	189.2	171.0	208.7	0.82	#
Black	49	133.8	92.0	186.0	0.77		21	108.0	55.7	182.9	0.97		28	179.2	112.5	267.6	0.78	
American Indian/Alaska Native	197	171.2	146.2	199.0	0.99		64	114.8	86.6	148.6	1.02		133	221.0	182.3	265.0	0.96	
Asian or Pacific Islander	159	134.1	113.1	157.7	0.77	#	46	107.4	75.8	146.5	0.96		113	156.0	127.9	188.3	0.68	#
Census tract-based poverty																		
0% - <5% poverty	1,067	168.4	158.0	179.3	-		313	104.3	92.4	117.2	-		754	229.5	212.8	247.1	-	
5% - <10% poverty	4,193	172.2	166.9	177.7	1.02		1,208	104.9	98.9	111.2	1.01		2,985	235.4	226.8	244.2	1.03	
10% - <20% poverty	8,305	172.9	169.1	176.7	1.03		2,638	115.2	110.7	119.8	1.10		5,667	227.2	221.2	233.4	0.99	
20% + poverty	2,357	180.8	173.4	188.4	1.07		745	124.1	115.2	133.5	1.19	#	1,612	233.1	221.6	245.1	1.02	
Census tract-based education																		
40%+ college degree	2,298	163.6	156.8	170.7	-		648	98.0	90.3	106.2	-		1,650	224.1	213.1	235.5	-	
30% - <40% college degree	1,865	165.2	157.7	173.1	1.01		531	102.8	94.0	112.2	1.05		1,334	223.1	211.0	235.7	1.00	
20% - <30% college degree	4,572	177.5	172.3	182.9	1.08	#	1,433	117.5	111.3	124.0	1.20	#	3,139	233.9	225.6	242.5	1.04	
15% - <20% college degree	3,133	172.9	166.8	179.2	1.06		982	113.6	106.5	121.2	1.16	#	2,151	228.5	218.7	238.7	1.02	
<15% college degree	4,054	179.8	174.2	185.5	1.10	#	1,310	121.3	114.7	128.2	1.24	#	2,744	235.6	226.7	244.8	1.05	
Census tract-based uninsured																		
<15% uninsured	3,012	169.1	163.0	175.4	-		860	103.0	96.0	110.3	-		2,152	230.1	220.2	240.3	-	

15% - <25% uninsured	6,036	173.3	168.8	177.8	1.02		1,883	114.4	109.1	119.8	1.11	#	4,153	229.1	222.1	236.4	1.00
25% - <35% uninsured	4,578	173.0	167.9	178.2	1.02		1,456	114.4	108.4	120.6	1.11	#	3,122	228.4	220.3	236.9	0.99
35%+ uninsured	2,296	181.1	173.7	188.9	1.07	#	705	119.0	110.2	128.3	1.16	#	1,591	238.9	227.1	251.3	1.04

Notes:

Rates are per 100,000 and age-adjusted to the 2000 US Standard Population (19 age groups - Census P25-1130) standard. Confidence intervals (Tiwari) are 95% for rates.

The rate ratio indicates that the incidence rate is significantly different from the rate for the referent group ($p<0.05$).

167 cases had missing information on race or ethnicity.

Rates for age groups are not age-adjusted.

Tables 2. Number and average annual age-adjusted rate of overweight- and obesity-related cancer cases and estimated prevalence of normal body weight among adult population, by geographic area -- Idaho, 2012-2016.

Geographic Area	Cases	Rate	Lower CI	Upper CI	Rate Ratio		Normal Weight
State of Idaho	15,922	173.3	170.5	176.1	-		32.7%
Health District 1	2,766	180.8	173.9	188.0	1.04	#	34.1%
Health District 2	1,164	164.2	154.6	174.3	0.95		35.5%
Health District 3	2,763	190.1	182.9	197.4	1.10	#	26.6%
Health District 4	4,393	174.9	169.6	180.3	1.01		36.5%
Health District 5	1,719	158.6	151.1	166.5	0.92	#	29.5%
Health District 6	1,420	158.1	149.7	166.7	0.91	#	31.1%
Health District 7	1,697	168.4	160.3	176.8	0.97		32.2%
Ada County	3,970	176.8	171.2	182.5	1.02		36.9%
Adams County	42	124.1	85.6	177.9	0.72		27.3%
Bannock County	644	150.0	138.4	162.4	0.87	#	33.3%
Bear Lake County	54	135.8	99.4	181.7	0.78		35.3%
Benewah County	118	164.0	134.4	199.1	0.95		25.9%
Bingham County	421	182.3	164.9	200.9	1.05		28.6%
Blaine County	176	126.4	107.5	147.9	0.73	#	46.9%
Boise County	86	163.1	125.8	209.7	0.94		32.0%
Bonner County	551	166.1	151.6	181.7	0.96		36.8%
Bonneville County	944	175.9	164.7	187.7	1.02		29.8%
Boundary County	146	168.7	141.0	201.1	0.97		29.5%
Butte County	32	176.7	116.7	259.2	1.02		29.6%
Camas County	12	170.7	79.7	326.3	0.99		~
Canyon County	1,928	190.7	182.1	199.5	1.10	#	26.7%
Caribou County	64	152.9	116.7	197.3	0.88		22.9%
Cassia County	195	156.7	135.2	180.8	0.90		31.9%
Clark County	10	184.1	87.9	348.3	1.06		~
Clearwater County	136	179.3	148.9	215.6	1.03		29.1%
Custer County	59	169.5	124.6	227.8	0.98		33.9%
Elmore County	229	179.1	156.3	204.3	1.03		27.4%
Franklin County	113	169.9	139.5	205.0	0.98		28.9%
Fremont County	132	170.3	141.8	203.1	0.98		26.6%
Gem County	249	206.4	179.9	236.0	1.19	#	21.0%
Gooding County	147	160.6	135.2	189.6	0.93		26.7%
Idaho County	207	147.4	126.9	170.9	0.85	#	32.4%
Jefferson County	193	156.2	134.5	180.3	0.90		29.0%
Jerome County	183	160.2	137.4	185.7	0.92		23.2%
Kootenai County	1,763	186.2	177.4	195.4	1.07	#	34.9%
Latah County	294	161.1	142.7	181.1	0.93		41.4%
Lemhi County	132	173.5	143.1	210.2	1.00		34.3%

Lewis County	51	180.3	129.8	246.0	1.04		32.9%
Lincoln County	42	149.7	106.9	204.1	0.86		34.4%
Madison County	176	168.2	143.4	195.7	0.97		39.3%
Minidoka County	179	147.1	125.9	171.0	0.85	#	22.0%
Nez Perce County	476	171.8	156.2	188.6	0.99		32.8%
Oneida County	33	123.2	82.4	178.1	0.71		32.9%
Owyhee County	119	171.3	141.1	206.3	0.99		25.7%
Payette County	284	204.4	180.7	230.4	1.18	#	30.4%
Power County	59	130.9	99.0	170.4	0.76	#	28.1%
Shoshone County	188	194.9	166.2	227.7	1.12		26.0%
Teton County	51	101.3	73.6	136.2	0.58	#	43.9%
Twin Falls County	785	170.9	158.9	183.5	0.99		27.8%
Valley County	108	132.3	106.1	164.0	0.76	#	44.8%
Washington County	141	173.5	145.1	206.9	1.00		26.4%

Notes:

Rates are per 100,000 and age-adjusted to the 2000 US Standard Population (19 age groups - Census P25-1130) standard. Confidence intervals (Tiwari) are 95% for rates.

The rate ratio indicates that the incidence rate is significantly different from the rate for the state of Idaho referent group ($p<0.05$).

Proportion with normal weight (body mass index [BMI] 18.5-24.9 kg/m^2) estimated from 2013-2013 BRFSS data (details in methods section).

~ Statistic could not be calculated.

Table 3. Age-adjusted incidence of overweight- and obesity-related cancer, changes in rates, and estimated percent increase in cancer risk associated with change in BMI, by cancer site and sex -- Idaho, 2007-2016.

	2007-2016	2007-2011			2012-2016			2007-2016	% Increase in risk for cancer per 1 kg/m^2 increase in BMI
Primary Site Category	%	Rate	Lower CI	Upper CI	Rate	Lower CI	Upper CI	AAPC	
Breast (in postmenopausal women)	30	338.1	327.6	348.8	343.6	333.8	353.6	0.2	2
Colon & rectum	21	39.6	38.2	41.0	35.2	34.0	36.5	-2.2^	2
Male		45.0	42.8	47.3	38.9	37.0	40.9	-2.6^	
Female		34.5	32.7	36.3	32.0	30.3	33.7	-1.7	
Thyroid	9	16.5	15.6	17.5	15.8	15.0	16.8	-0.8	1
Male		7.4	6.6	8.3	7.5	6.6	8.4	-0.2	
Female		25.7	24.1	27.4	24.3	22.8	25.9	-1.0	
Kidney (renal cell)	8	14.3	13.5	15.2	14.9	14.1	15.7	0.7	5
Male		18.5	17.1	19.9	19.6	18.3	21.0	0.8	
Female		10.6	9.6	11.7	10.5	9.6	11.5	0.3	
Endometrium (corpus uterus) (female only)	8	24.1	22.6	25.7	25.3	23.8	26.8	0.9	8
Pancreas	7	11.7	10.9	12.4	13.1	12.4	13.9	2.0^	2
Male		12.8	11.6	14.0	15.1	13.9	16.3	2.7	
Female		10.6	9.7	11.7	11.3	10.3	12.3	1.5	
Meningioma	4	8.1	7.5	8.8	7.9	7.3	8.5	-0.3	4
Male		5.1	4.4	6.0	4.8	4.2	5.6	-1.5	
Female		10.9	9.9	12.0	10.8	9.8	11.8	0.2	
Ovary (female only)	3	12.2	11.2	13.4	11.2	10.3	12.3	-2.7^	1
Multiple myeloma	3	5.8	5.2	6.3	5.8	5.3	6.4	0.4	2
Male		7.8	6.8	8.8	7.3	6.5	8.2	-0.9	
Female		4.2	3.6	4.9	4.5	3.9	5.1	0.8	
Liver	3	4.6	4.1	5.1	5.6	5.2	6.1	4.4^	5
Male		7.1	6.3	8.0	8.7	7.8	9.6	4.4^	
Female		2.3	1.8	2.8	2.8	2.3	3.3	3.7	
Adenocarcinoma of the esophagus	2	3.3	2.9	3.7	3.3	2.9	3.7	0	9
Male		6.3	5.5	7.2	6.2	5.4	7.0	-0.6	
Female		0.5	0.3	0.8	0.7	0.5	1.0	3.1	
Gastric cardia	1	2.0	1.7	2.3	2.3	2.0	2.6	2.57	4
Male		3.6	3.0	4.3	3.8	3.2	4.4	0.99	
Female		0.5	0.3	0.8	1.0	0.7	1.3	4.84	
Gallbladder	1	1.1	0.9	1.3	0.9	0.7	1.2	0.96	5
Male		0.6	0.4	0.9	1.0	0.7	1.3	5.26	
Female		1.5	1.2	2.0	0.9	0.7	1.2	-4.1	
All overweight- and obesity-related cancers	-	174.6	171.7	177.6	173.3	170.5	176.1	-0.2	-

Male		114.2	110.7	117.8	112.7	109.5	116.0	-0.3	
Female		231.1	226.5	235.8	230.1	225.7	234.6	-0.1	
All overweight- and obesity-related cancers except colorectal cancer	-	135.1	132.5	137.7	138.0	135.6	140.5	0.3	-
Male		69.2	66.5	72.0	73.8	71.2	76.5	1.1^	
Female		196.7	192.4	201.0	198.1	194.1	202.2	0.1	
Cancers not related to overweight and obesity	-	288.3	284.5	292.1	258.3	254.9	261.7	-1.9^	-
Male		401.8	395.2	408.4	336.1	330.5	341.7	-3.1^	
Female		189.6	185.3	194.0	191.1	187.0	195.4	0.0	