Oregon Health Authority
Environmental Public Health Tracking

DMV records are valuable for obesity surveillance in Oregon

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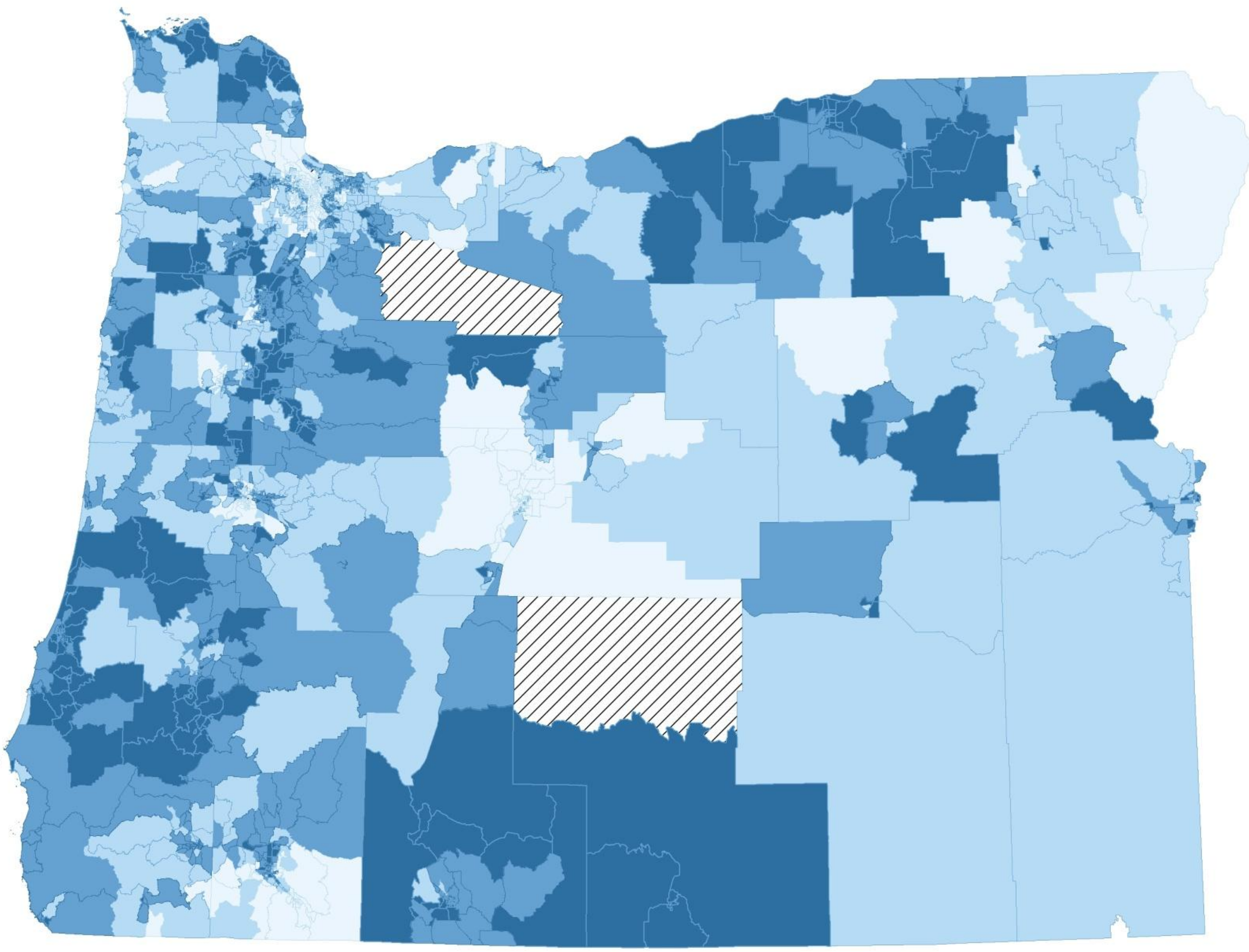

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Executive Summary

Obesity is one of the most pressing issues in public health today. Over one-third of U.S. adults are obese. Obesity greatly increases the risk for many diseases and lowers life expectancy. Public health surveillance of obesity is important for monitoring trends, highlighting disparities, identifying risk factors, guiding prevention programs and evaluating interventions.

Data from state-issued driver licenses and ID cards (DMV data) are a valuable resource for obesity surveillance in Oregon. DMV records can produce precise estimates of the population's weight status for small areas throughout the state. Oregon will be the first state to incorporate DMV data into the public health surveillance system. This report presents findings from the largest validation study conducted on DMV records and demonstrates applications for the data.

Key points:

- DMV data is of good quality, inexpensive, flexible, stable, sensitive and representative of the adult population in Oregon.
- Compared to self-reported data from the Behavioral Risk Factor Surveillance System, body mass index (BMI) estimates from DMV records averaged 1.9 percent lower for men and 5.2 percent lower for women. This indicates women are more likely than men to under-report their weight on a driver license or ID card.
- Compared to self-reported data from the Behavioral Risk Factor Surveillance System, obesity prevalence estimates from DMV records averaged 17.9 percent lower for men and 28.5 percent lower for women. This suggests heavier people are more likely to under-report their weight on a driver license or ID card.
- Under reporting of weight in DMV records appears to be consistent, so the data can still be useful for describing temporal and spatial patterns throughout the state.
- Small-area estimates from DMV data reveal striking geographic variation in weight status. These estimates will be published on the Oregon Environmental Public Health Tracking Data Portal, greatly enhancing the ability of public health programs and advocates to describe disparities in obesity throughout the state of Oregon.

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Introduction

Obesity is one of the most pressing issues in public health today. Over one-third of U.S. adults are obese (1). Obesity greatly increases the risk for many diseases and lowers life expectancy. Public health surveillance of obesity is important for monitoring trends, highlighting disparities, identifying risk factors, guiding prevention programs, and evaluating interventions. Data from state Departments of Motor Vehicles (DMV) may be a valuable resource for obesity surveillance (2–4). Most states issue driver licenses and identification (ID) cards that contain information on age, sex, height, weight, and home address (5); see Appendix A for a complete list. Public health practitioners can use these data to generate population-based obesity estimates for small geographic areas.

Self-reported weight data on driver licenses are often assumed to be inaccurate. This is perhaps why DMV data have not previously been incorporated into public health surveillance systems. However, all self-reported data are subject to bias. The Behavioral Risk Factor Surveillance System (BRFSS), a random-digit-dial telephone survey, underestimates obesity prevalence (6) because people tend to overestimate their height and underestimate their weight (7,8). Though the estimates are conservative, the BRFSS remains one of the primary sources for adult obesity estimates at the state and county level (9).

Only a few studies validating information on driver licenses have been published, but findings are consistent. On average, driver licenses underestimated weight by 10.4 pounds and overestimated height by 0.8 inches for 143 Asian-American women in Hawaii (10). Another study of 480 women under the age of 45 found driver licenses underestimated weight by 13.0 pounds and overestimated height by 0.1 inches, though there were strong correlations between reported and measured values (11). Finally, a study of 512 university students found driver licenses overestimated height by an average 0.2 inches for women and 0.5 inches for men, but did not compare weights (12) .

Even though height and weight information on a driver license may be predictably biased, DMV data may still be useful for population-based surveillance of obesity. To our knowledge, no study has evaluated DMV records for that purpose. This evaluation seeks to fill that gap, following guidance for evaluating public health surveillance systems from the Centers for Disease Control and Prevention (13).

Materials and Methods

SAS 9.2, SPSS 19.0, and Microsoft Excel 2007 were used for analysis. ESRI ArcGIS 10.0 was used to geocode DMV data and create maps. This evaluation was deemed exempt from IRB review by the Oregon Public Health Division’s Project Review Committee.

All Oregon driver licenses and ID cards are issued and renewed in person at a DMV office, effective October 1, 2004. Prior to that date, about one-third of all renewals were done by mail (14). ID cards may only be issued to people who do not have a driver license (15). The most recently reported height and weight information is included in the DMV record. Before January 1, 2012, DMV employees were instructed to ask applicants renewing a card or license if their height or weight had changed. If so, the updated information was entered on the applicant's record. Since January 1, 2012, applicants for a new, renewal, or replacement driver's license or ID card are required to fill out the same form, which collects information on date of birth, sex, address, height and weight (16).

DMV employees enter data from the completed form into the computer system. The information is then displayed on a screen for applicants to verify. Licenses are currently issued for eight years, expiring on the anniversary of the licensee's birthday in the eighth calendar year after the year of issuance (15). Eight-year renewals were phased in beginning October 2001. Until October 2004 both four-year and eight-year renewals were being issued (17). Address changes are permitted through the mail. Although state law requires people notify DMV of an address change, it is likely that many addresses are only updated every eight years (14).

DMV data for this evaluation were provided by the Driver and Motor Vehicle Services Division, a branch of the Oregon Department of Transportation. The cost was $900 for 3.5 million records issued or renewed between 2003 and 2010 (Table 1). Data fields include home address with zip code, date of birth, sex, height (in feet and inches), weight (in pounds), and the dates of the original card issue, the most recent card issue, and the card expiration. Race and ethnicity data are not collected by Oregon's DMV.

We excluded 1,714 duplicate records (0.05%) based on address, sex, birth date, weight, card issue date, and original card issue date. We also dropped 14,203 records for non-Oregon residents (0.40%); these records are created when out-of-state motorists are stopped for driving violations. There were no records with missing values for sex, date of birth, height, weight or issue date. We geocoded addresses and assigned DMV records to counties, census tracts and block groups based on 2010 Census boundaries. Zip codes were used to geocode addresses to counties when records could not be geocoded to tax lots or streets. Records that could not be geocoded to at least the county level were dropped (n=40,636, 1.14%).

Body mass index (BMI), expressed in units of kg/m^2, is the standard measure used for population-based obesity surveillance. Higher mean values indicate heavier populations. We computed BMI for each record. Conservative criteria were used to remove outliers in height (less than four feet or greater than seven feet), weight (less than 50 pounds or greater than 600 pounds), and BMI (less than 14.5 kg/m^2 or greater than 65 kg/m^2) (n=906, 0.024%). Since relatively few cases were removed during this processing step, mean BMI estimates would probably change little if these cases had been retained. Finally, to facilitate comparisons with Census and BRFSS data, records issued to people younger than 18 years and older than 84 years were excluded from analysis. The final evaluation sample contained 3,175,527 records for adults aged 18-84 years, issued between 2003 and 2010 (Table 1). For analysis, we age-adjusted estimates to the 2000 U.S. Census standard population.

Other data used in this evaluation are population estimates from the U.S. Census (18) and BMI estimates from the Oregon BRFSS (19). The BRFSS is a random-digit-dial telephone survey that collects data on health risks and behaviors from non-institutionalized adults. We used post-stratification weights to ensure BRFSS data are representative of the state's population and age-adjusted to the 2000 U.S. Census standard population; the weighting methodology is described in detail elsewhere (19). We used annual BRFSS survey data for state-level comparisons, and the combined years 2006-2009 to compare county-level BMI estimates. We used the years 2006-2009 for the county analysis because that four-year BRFSS dataset had already been created.

Following guidance for the evaluation of public health surveillance systems from the Centers for Disease Control and Prevention, we assessed DMV data for their utility for population-based surveillance of obesity. Key surveillance system attributes, identified by the CDC, include data quality, simplicity, representativeness, flexibility, acceptability, timeliness, stability, predictive value positive, sensitivity, and usefulness (13).

Data quality: Data quality reflects the completeness and validity of the data recorded in the public health surveillance system. Our assessment of data quality is based on cleaning and geo-coding the DMV dataset.

Simplicity: The simplicity of a public health surveillance system refers to both its structure and ease of operation. To assess simplicity, we described the process of retrieving DMV data, the file format and layout, and software used for analysis. We also reviewed available documentation and support from the Oregon Department of Transportation.

Representativeness: A public health surveillance system that is representative accurately describes the occurrence of a health-related event over time and its distribution in the population by place and person. We first assessed representativeness by comparing the number and distribution of DMV records issued in 2010 with the Census population counts to determine how well the population distribution in the DMV data matched that of the entire population. We grouped the DMV records and Census data by county, sex, and 14 age categories (18-19, 20-24, 25-29, 30-34, 35-39, 40-44, 45-49, 50-54, 55-59, 60-64, 65-69, 70-74, 75-79, and 80-84), and compared counts with Pearson's correlation coefficient. Next, we compared BMI estimates between the BRFSS survey and the DMV records to determine how reliable the height and weight information from driver licenses was relative to BRFSS survey data. We compared age-adjusted, county-level mean BMI values from BRFSS data and DMV records for years 2006 through 2009 combined. Three adjacent counties with low populations (Gilliam, Sherman, and Wasco) were pooled for the BMI comparison. Pearson's correlation coefficient was used for this comparison as well.

Flexibility: A flexible public health surveillance system can adapt to changing information needs or operating conditions with little additional time, personnel, or allocated funds. Our assessment of flexibility is based on the various measures we computed from DMV data. We also consider how flexible the DMV is to change data elements or data collection procedures.

Acceptability: Acceptability reflects the willingness of persons and organizations to participate in the surveillance system. We assessed the general public's willingness to provide personal information to the DMV, and whether DMV was willing and able to provide driver license and ID card records containing biometric data. We also assessed whether Oregon's state public health agency was willing to publish estimates based on DMV data.

Timeliness: Timeliness reflects the speed between steps in a public health surveillance system. We examined how the DMV database is updated, the response time for a data request, and the time needed for analysis. We also considered the time it takes for individuals' height and weight information to be updated in DMV records.

Stability: Stability refers to the ability of a surveillance tool to collect, manage, and provide data properly without failure, and its ability to be operational when it is needed. To assess stability, we reviewed Oregon Revised Statutes related to driver licenses and ID cards and the administration of the DMV by the Oregon Department of Transportation. We also describe the cost to obtain DMV data for this evaluation, which affects the ability of the public health agency to incorporate DMV data into a surveillance system.

Predictive Value Positive: Predictive value positive is the proportion of reported cases that actually have the health-related event under surveillance. We did not directly assess predicted value positive, which would require follow-up with individual card holders to obtain current measurements (Oregon law prohibits the use of DMV data for contacting individuals for research studies). Instead, we compared estimates from DMV records with estimates from the Oregon BRFSS. We used t tests to compare state-level estimates of mean height, weight, and BMI from DMV and BRFSS data.

Sensitivity: The sensitivity of a surveillance system can be considered on two levels. First, at the level of case reporting, sensitivity refers to the proportion of cases of a disease (or other health-related event) detected by the surveillance system. Second, sensitivity can refer to the ability to detect outbreaks, including the ability to monitor changes in the number of cases over time.

To assess sensitivity, we grouped DMV records into 5-year birth cohorts and compared the mean BMI value for each cohort for each year. For each cohort, we used a simple linear regression model to describe the average yearly change in mean BMI from 2003-2010.

Usefulness: A public health surveillance system is useful if it contributes to the prevention and control of adverse health-related events. Surveillance systems can also be useful by producing health indicators for needs assessments and accountability systems. Ultimately, estimates from DMV records will be useful if they inform interventions that lower obesity rates. In the meantime, we consider usefulness in terms of the geographic resolution of BMI estimates from DMV data.

Results

Data quality: Table 1 shows the evaluation sample. Less than two percent of the records were removed for data issues. No records had missing values for height or weight. The ArcGIS software geocoded 72.0% of the records to the tax lot (point location), and an additional 23.3% to the street (95.3% combined). A final 3.6 percent were geocoded to the county level. We attribute these high match rates to the quality of address information kept on file at the DMV, and the efficacy of the software used for geocoding.

The data quality of DMV address information is likely high because of the data checking procedures in place at DMV offices and widespread reliance upon the data by such diverse entities as the Oregon State Police, motor vehicle manufacturers, attorneys, insurers and organ procurers. DMV phased in eight-year renewals between the years 2001 and 2004; previously cards were issued for four years. People who were issued a driver license or ID card with a four year renewal period in 2003 or 2004 would have had to renew their card before 2010. This explains why fewer records in the current DMV set were issued in 2003 or 2004 compared to more recent years. Most records in the data set represented renewals; only 2.8% were the original issue.

We excluded BMI estimates for 15 block groups (out of 2,634) for having fewer than 50 records. Few people live within these areas, which together contain 0.42% of Oregon's population. Eight of the 15 block groups have zero population, according to the Census. Estimates for the other seven block groups were excluded primarily due to our inability to geocode enough addresses within these areas.

Table 1. Sample demographics: DMV records issued to adults ages 18-84, 2003-2010

Year	N	% Female	Mean age in years (sd)	% New issues
2003	231,635	48.8%	45.3 (17.4)	7.1%
2004	308,527	49.6%	46.4 (17.0)	3.4%
2005	447,267	49.5%	45.6 (16.4)	2.7%
2006	459,644	47.4%	43.8 (16.1)	3.0%
2007	485,474	46.9%	43.0 (16.0)	2.6%
2008	422,577	48.0%	42.8 (15.9)	1.7%
2009	380,826	48.9%	41.2 (16.5)	2.1%
2010	439,577	50.5%	41.8 (17.3)	1.9%
Total	3,175,527	48.6%	43.6 (16.6)	2.8%

Simplicity: After completing a data request, we received DMV data on a DVD, in a flat file format. Data field names and values were easy to interpret. Because only a few fields are available in the DMV dataset, data cleaning and analysis was simple. All analyses could be conducted with standard statistical software. Representatives of the Oregon Department of Transportation were available by phone or email to answer questions.

Representativeness: The final evaluation sample contained 3,175,527 records for adults aged 18-84 years, issued between 2003 and 2010. According to the Census, there were 2,886,749 adults aged 18-84 years living in Oregon in 2010. Given that records were de-duplicated, this finding suggests the DMV database still contains records for people who are deceased, or who have moved out of state. The evaluation sample included 439,581 records issued to adults aged 18-84 years during 2010, which represents 15% of the Oregon population within that age group. DMV records may capture data from certain groups traditionally excluded from the BRFSS, such as students living in dormitories, inmates with shorter incarceration periods, and adults living in group homes.

A correlation coefficient of +1 indicates a perfect linear relationship between two variables; when one variable increases, the other increases by the same amount. A correlation of -1 also indicates a perfect linear relationship, with one variable decreasing when the other increases. A correlation of zero indicates there is no linear relationship between two variables.

The 2010 census population counts from Oregon's 36 counties correlated strongly with the number of driver licenses and ID cards issued or renewed to people in those counties in 2010, with $r_{women}(34) = 0.999$ ($p<0.001$) and $r_{men}(34) = 0.998$ ($p<0.001$). (The parentheses contain the degrees of freedom of the calculation.) Further splitting the sample into 14 age groups, we found $r_{women}(504) = 0.947$ ($p<0.001$) and $r_{men}(504) = 0.956$ ($p<0.001$). This is strong evidence the DMV data are representative of the adult population distribution among counties in Oregon.

Age-adjusted county-level BMI estimates for men from DMV records issued between 2006 and 2009 were significantly correlated with corresponding estimates from the BRFSS, $r_{men}(32) = 0.518$ ($p<0.001$). For women the correlation was stronger, at $r_{women}(32) = 0.699$ ($p<0.001$). These correlations are not as strong as those for population counts, but still show that the county BMI estimates from DMV and BRFSS track together.

Flexibility: Address information in DMV records allows for great flexibility in defining geographic areas for analysis. We created BMI estimates for geographic areas as small as Census block groups, by sex and age, by combining DMV records issued between 2006 and 2010. Birth dates allow for great flexibility in defining age groups.

One interesting finding is that 89% of reported weights were multiples of five. This could limit the resolution of the BMI estimates. From another perspective, it may be very difficult for the DMV to make changes to data elements or data collection procedures, like installing scales to capture weight information. In this regard, the DMV database may be considered inflexible.

Acceptability: The DMV database contains records for nearly every adult in the state, indicating the general public's willingness to get driver licenses or ID cards and provide information to the DMV. According to Oregon statutes, "the Department of Transportation, upon request or as required by law, shall disclose personal information from a motor vehicle record to a government agency for use in carrying out its governmental functions" (20). For example, law enforcement agencies and elections officials use DMV data to locate people.

Surveillance of BMI was recognized as a key public health function by the Oregon Department of Transportation when the data were provided. Oregon's state public health agency demonstrated willingness to buy, analyze, and publish BMI estimates from DMV records. Data are also available to health researchers: "The department shall disclose personal information other than names to a researcher for use in researching health and educational questions and providing statistical reports, as long as the personal information is not published, redisclosed or used to contact individuals" (20).

Timeliness: The DMV database is updated continuously as people get new licenses, renew a license, move out of state, or die. With an eight-year renewal cycle, height and weight data in individual records are not updated frequently. (People are supposed to update their addresses every time they change residences, but the address change form does not gather updated height and weight data.) An updated version of the database can be acquired quickly, within a week or two. We worked for several months analyzing data for this evaluation. With syntax now created to analyze DMV records, we anticipate future analyses will be done more quickly.

Stability: The DMV database is highly stable. State law requires all persons operating a motor vehicle to have a valid driver license or learning permit. People who move to the state are allowed to use their current, out-of-state license for 30 days, but must then acquire an Oregon-issued license if they wish to keep driving in the state.

DMV operations are supported by fees (20), and are thus buffered from threats to funding. The Oregon Department of Transportation is required by statute to collect and store biometric data, so there will always be a need for a database. We paid $900 for the data used in this evaluation, a small sum for the quantity of information received. The low cost makes these data accessible to public health practitioners, so surveillance with DMV records may continue even when little funding is available.

Predictive Value Positive: Table 2 shows statewide mean height estimates by sex. For women, height estimates from DMV records averaged 0.01 percent lower than BRFSS estimates for the years 2003 through 2010. For men, DMV height estimates averaged 0.23 percent lower than BRFSS estimates. Though the magnitude of the differences was slight, the large sample sizes led to statistically significant findings for most years (at $p<0.001$) for men, but only two of the eight years for women.

Table 2. Age-adjusted height estimates from DMV records and the BRFSS, 2003-2010

		DMV Height (feet)		BRFSS Height (feet)		Significance		
	Year	Mean	Std Dev	Mean	Std Dev	t	df	p<.001
Women								
	2003	5.380	0.227	5.385	0.286	-1.06	4268	no
	2004	5.381	0.228	5.392	0.273	-2.60	5014	no
	2005	5.386	0.228	5.386	0.285	0.03	9188	no
	2006	5.387	0.231	5.394	0.322	-1.45	6014	no
	2007	5.388	0.231	5.390	0.341	-0.42	6067	no
	2008	5.398	0.228	5.389	0.335	1.98	5675	no
	2009	5.400	0.228	5.414	0.371	-2.26	3926	no
	2010	5.401	0.228	5.386	0.372	3.06	5999	no
Men								
	2003	5.818	0.267	5.864	0.292	-8.32	2911	yes
	2004	5.839	0.260	5.871	0.311	-5.81	3197	yes
	2005	5.844	0.260	5.847	0.328	-0.64	5847	no
	2006	5.842	0.262	5.868	0.332	-4.70	3674	yes
	2007	5.841	0.263	5.868	0.341	-4.80	3761	yes
	2008	5.871	0.249	5.871	0.363	-0.06	3649	no
	2009	5.882	0.242	5.891	0.345	-1.42	2587	no
	2010	5.882	0.243	5.860	0.403	3.52	4154	yes

Table 3 shows statewide mean weight estimates from the BRFSS and DMV data by sex. In the DMV data set every record contained height and weight information, but some BRFSS respondents report height but not weight.

For the years 2003 – 2010, age-adjusted annual DMV means for men averaged 4.4 pounds (2.2 percent) lower than the BRFSS estimates. For women, age-adjusted annual estimates from DMV records averaged 8.3 pounds (5.2 percent) lower than the BRFSS estimates. There were statistically significant differences between annual DMV and BRFSS estimates for all years (p<0.001).

Table 3. Age-adjusted weight estimates from DMV records and the BRFSS, 2003-2010

	DMV Weight (pounds)		BRFSS Weight (pounds)		Significance		
Year	Mean	Std Dev	Mean	Std Dev	t	df	p<0.001
Women							
2003	147.888	31.980	155.993	40.437	42.7	4009	yes
2004	148.798	32.671	157.337	43.640	45.2	4741	yes
2005	150.763	33.730	157.311	44.183	61.8	8701	yes
2006	151.701	34.429	159.137	49.313	48.0	5701	yes
2007	152.158	34.832	160.904	52.922	46.5	5805	yes
2008	152.174	34.915	158.782	49.442	47.0	5414	yes
2009	151.121	34.989	160.864	58.416	35.0	3749	yes
2010	151.100	34.815	161.685	66.188	39.3	5689	yes
Men							
2003	184.045	35.290	190.521	41.712	39.5	2892	yes
2004	186.520	35.921	192.591	45.816	40.8	3201	yes
2005	188.537	36.564	191.882	46.356	55.7	5833	yes
2006	189.348	37.352	194.261	50.055	43.0	3660	yes
2007	189.892	37.898	195.242	49.802	43.6	3748	yes
2008	192.641	38.227	195.732	52.077	43.0	3645	yes
2009	192.136	38.423	195.221	59.508	34.3	2575	yes
2010	191.879	38.557	196.166	59.924	42.9	4138	yes

Table 4 shows mean BMI estimates from the BRFSS and DMV data by sex. The DMV estimates show less year-to-year variability than the BRFSS. The large sample sizes led to statistically significant differences between annual DMV and BRFSS estimates for nearly all years ($p<0.001$). DMV mean BMI for men averaged 0.52 kg/m^2 (1.9 percent) lower than the BRFSS estimates. For women, DMV mean BMI averaged 1.38 kg/m^2 (5.2 percent) lower than the BRFSS estimates.

The differences between DMV and BRFSS estimates were fairly consistent between 2003 and 2009, but the estimates deviated more in 2010. Mean BMI from DMV data peaked in 2007 for women and in 2008 for men (Figure 1). Visually, the DMV estimates are lower than the BRFSS estimates but appear to trend consistently over time.

Table 4. Age-adjusted BMI estimates from DMV records and the BRFSS, 2003-2010

	DMV		BRFSS		Significance		
Year	Mean BMI	Std Dev	Mean BMI	Std Dev	t	df	p<.001
Women							
2003	24.94	5.17	26.29	6.76	-12.23	3962	yes
2004	25.08	5.28	26.42	7.07	-12.57	4682	yes
2005	25.37	5.45	26.49	7.15	-14.06	8599	yes
2006	25.52	5.58	26.70	7.83	-11.13	5660	yes
2007	25.59	5.64	27.05	8.82	-12.38	5751	yes
2008	25.50	5.63	26.72	7.96	-11.07	5382	yes
2009	25.29	5.62	26.74	9.21	-9.53	3734	yes
2010	25.29	5.59	27.21	11.14	-12.87	5655	yes
Men							
2003	26.48	4.34	27.06	4.90	-6.18	2878	yes
2004	26.64	4.43	27.20	5.61	-5.53	3171	yes
2005	26.88	4.51	27.37	5.97	-6.04	5774	yes
2006	27.01	4.62	27.49	6.31	-4.48	3637	yes
2007	27.10	4.70	27.53	6.45	-3.98	3727	yes
2008	27.23	4.80	27.69	6.65	-4.13	3630	yes
2009	27.06	4.87	27.42	7.40	-2.39	2571	no
2010	27.02	4.90	27.84	7.58	-6.86	4126	yes

Figure 1. Age adjusted BMI estimates from DMV records and the BRFSS, 2003 - 2010

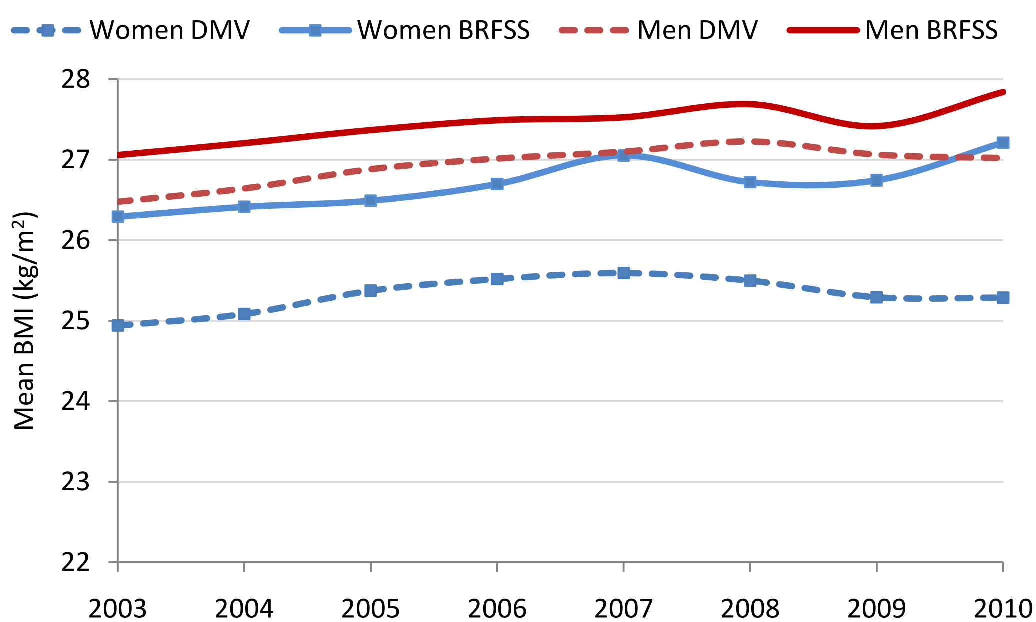


Table 5 shows age-adjusted obesity prevalence estimates from the BRFSS and DMV data by sex. DMV obesity prevalence estimates for men averaged 17.9% lower than estimates from the BRFSS. For women, obesity prevalence estimates averaged 30.8% lower than the BRFSS. The magnitude of these differences is much greater than that for mean BMI, indicating that the greatest underestimation of weight occurs among the heaviest people.

Table 5. Age-adjusted obesity prevalence estimates (BMI > 30 kg/m2) from DMV records and the BRFSS, 2003-2010

Year	DMV % Obese	BRFSS % Obese	% difference (DMV- BRFSS)/BRFSS
Women			
2003	14.4%	21.4%	-32.6%
2004	15.3%	22.1%	-30.7%
2005	16.8%	23.3%	-28.0%
2006	17.7%	24.5%	-27.7%
2007	18.1%	26.1%	-30.6%
2008	17.7%	24.3%	-27.0%
2009	17.0%	25.3%	-33.1%
2010	16.8%	26.5%	-36.7%
Men			
2003	17.1%	22.3%	-23.3%
2004	18.2%	22.3%	-18.5%
2005	19.9%	24.2%	-18.0%
2006	20.8%	25.1%	-17.1%
2007	21.5%	26.8%	-19.9%
2008	22.6%	26.5%	-14.8%
2009	22.1%	24.2%	-8.7%
2010	21.8%	28.4%	-23.1%

This can be seen in Figures 2 and 3, which display normalized BMI distributions from BRFSS and DMV records from the period 2006 – 2009. The peaks of the distributions line up, but the DMV curve is skewed towards smaller BMI values.

This is more pronounced in Figure 2, the graph for women. If underestimation of weight were consistent, the distributions would be offset but would have the same shape.

Figure 2. Normalized BMI distributions from DMV records and the BRFSS, women 2006-2009

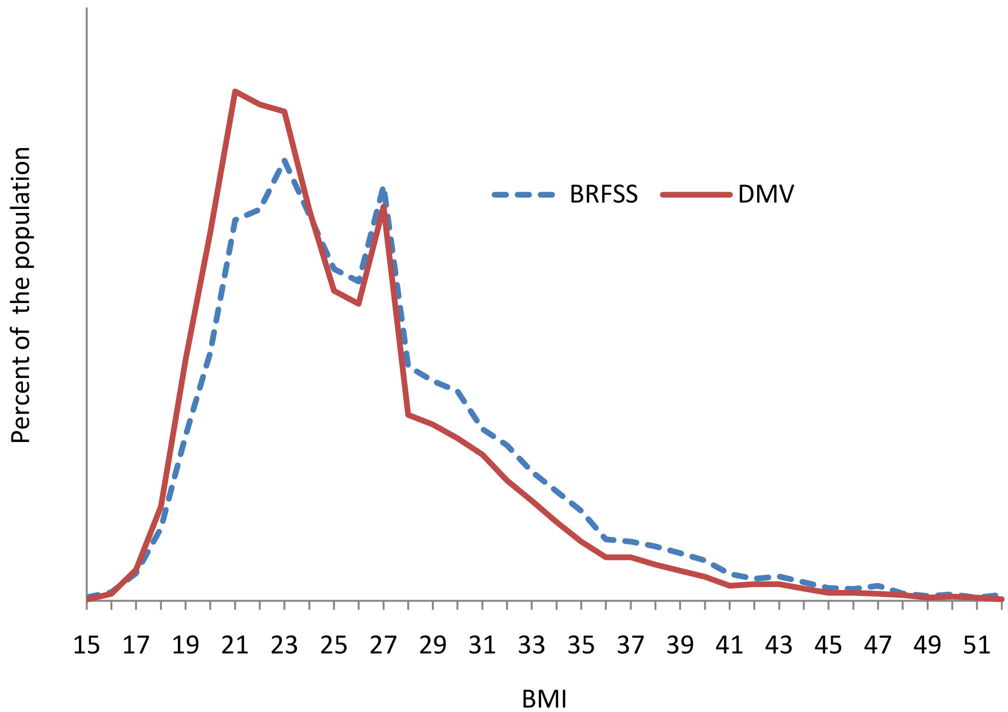


Figure 3. Normalized BMI distributions from DMV records and the BRFSS, men 2006-2009

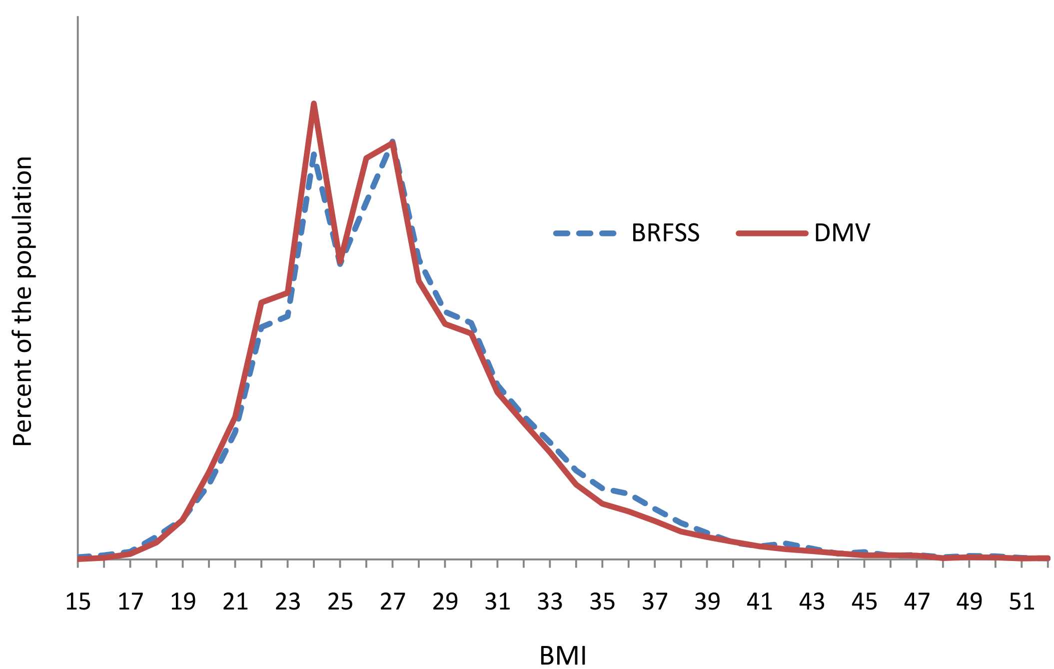


Table 6 compares mean BMI estimates from new records and renewals, by sex and age group. New records are predominantly issued to younger adults. Interestingly, average BMI from new records for women was higher than for renewals (p<0.001 for ages 18-64, p<0.05 age 65-84). For men, average BMI from new records was lower than for renewals (p<0.001 all age groups).

Table 6. Age-specific BMI estimates from new records and renewals, DMV records 2003-2010

	New			Renewal			Significance		
Age group	N	Mean BMI	Std Dev	N	Mean BMI	Std Dev	t	df	p<.001
Women									
18-34	25,526	24.66	5.40	498,539	24.38	5.21	8.17	28,015	yes
35-49	6,196	26.67	6.10	425,605	25.54	5.67	14.49	6,352	yes
50-64	4,170	27.37	6.44	373,919	26.31	5.67	10.58	4,241	yes
65-84	4,701	26.30	5.73	205,230	26.13	5.01	2.04	4,866	no
Men									
18-34	36,473	25.31	4.48	566,503	26.02	4.61	-29.38	41,606	yes
35-49	7,480	26.92	4.52	452,998	27.56	4.64	-12.16	7,742	yes
50-64	3,068	26.88	5.09	372,628	27.81	4.64	-10.03	3,109	yes
65-84	1,792	25.83	4.65	190,699	27.33	4.22	-13.63	1,819	yes

Sensitivity: Figure 4 shows mean BMI by 5-year age cohort for women, by year of license issue. Figure 5 shows the same for men. For clarity, only odd years are shown in the graph. Visual inspection reveals mean BMI has increased for every birth cohort.

Figure 4. Mean BMI from DMV records for 5-year birth cohorts, women, 2003-2009 (odd years only)

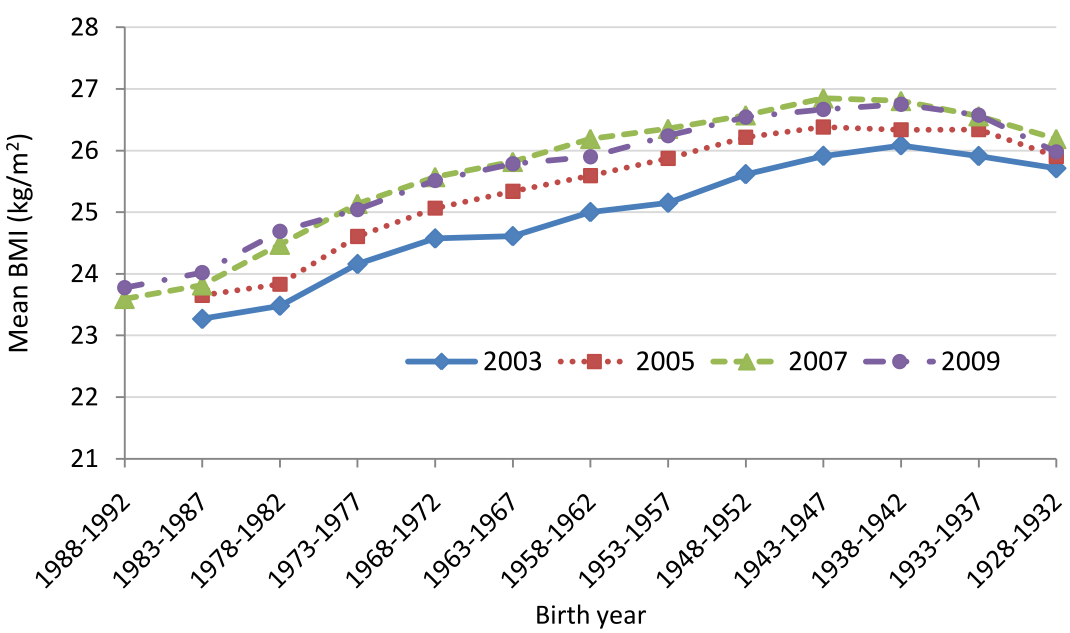


Figure 5. Mean BMI from DMV records for 5-year birth cohorts, men 2003-2009 (odd years only)

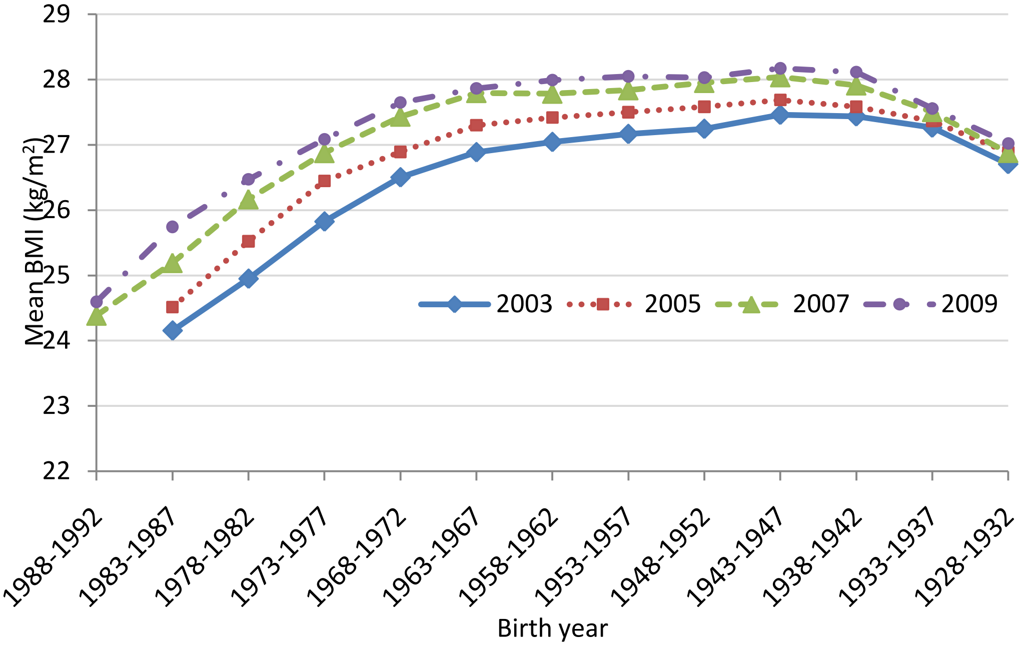


Table 7 shows regression results. The quadratic time term significantly improved the fit of nearly every model (F change significant at p<0.05). For every model, the positive coefficient for the time variable indicates mean BMI increased for every birth cohort over the time of the evaluation. The negative coefficients for the quadratic time terms indicate that the increase in BMI is slowing, and perhaps reversing.

Table 7. Linear regression results for 5-year birth cohorts, DMV records 2003-2010

	1988-1992	1983-1987	1978-1982	1973-1977	1968-1972	1963-1967	1958-1962	1953-1957	1948-1952	1943-1947	1938-1942	1933-1937	1928-1932
Women													
Constant	23.32	23.20	23.10	23.69	24.07	24.07	24.39	24.55	25.09	25.35	25.53	25.47	25.23
Time	.03	.15	.33	.42	.44	.54	.55	.59	.49	.50	.44	.42	.36
$Time^2$	.00	-.01	-.01	-.03	-.03	-.04	-.05	-.05	-.04	-.04	-.04	-.04	-.04
Adj. R^2	.94	.90	.97	.93	.95	.98	.90	.96	.95	.92	.80	.86	.62
Men													
Constant	23.35	23.88	24.50	25.40	26.14	26.47	26.70	26.87	26.86	27.12	27.07	27.07	26.49
Time	.32	.23	.42	.40	.33	.35	.31	.27	.31	.24	.26	.14	.17
$Time^2$	-.02	.00	-.02	-.02	-.02	-.02	-.02	-.01	-.02	-.01	-.02	-.01	-.02
Adj. R^2	.91	.98	.99	.98	.98	.96	.98	.98	.94	.91	.79	.74	.48

Usefulness: We produced block group, census tract, county, and state-level estimates of mean BMI for men, women, and all adults. Before age-adjusting, the block group with the lowest BMI in the state was located on the Oregon State University campus, where the only residences are student dorms. That block group had few residents over the age of 25, so the average BMI was skewed downward sharply simply because of the unusual age distribution.

Age-adjusting the DMV data makes it easier to compare block groups. Figure 6 shows age-adjusted mean BMI by Census block group for the combined years 2006 through 2010.

In darker areas on the map, mean BMI is statistically higher than the state average (at $p<0.05$); lighter areas have mean BMI significantly lower than the state average. Block groups for which estimates are unreliable are marked with cross-hatching.

Block groups in eastern Oregon are larger because the population density is lower. The block groups with the five highest average BMI values are all on or adjacent to Indian reservations.

Figure 6. Age-adjusted mean BMI by Census block group, DMV 2006-2010

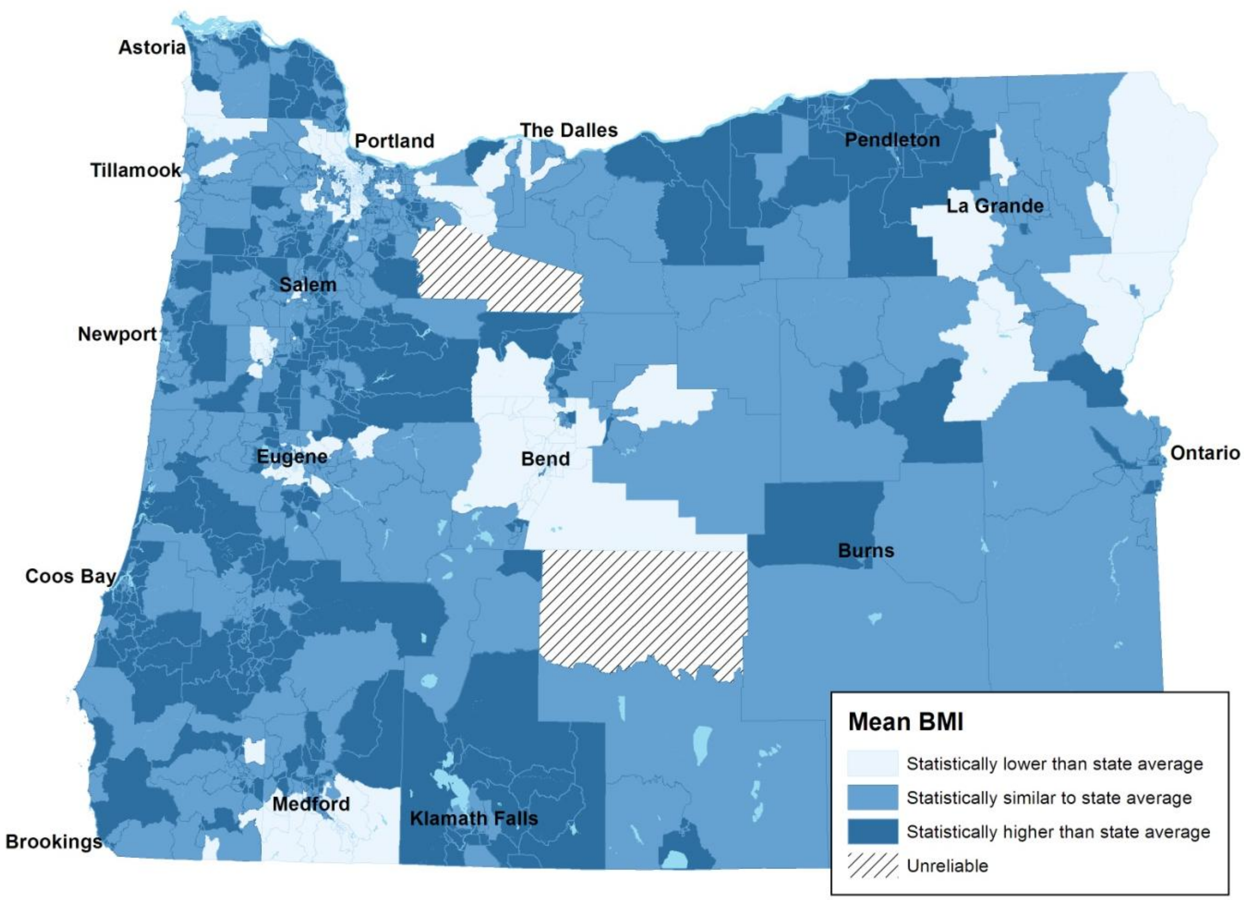


Figure 7 shows age-adjusted mean BMI by block group in the Portland Metropolitan area. Block groups are classified into quartiles based on all block groups in the Portland area, with darker colors representing higher mean BMI. BMI is lower in the city of Portland and higher in many surrounding communities.

Figure 7. Age-adjusted mean BMI by Census block group, Portland Metropolitan Area, from DMV records 2006-2010

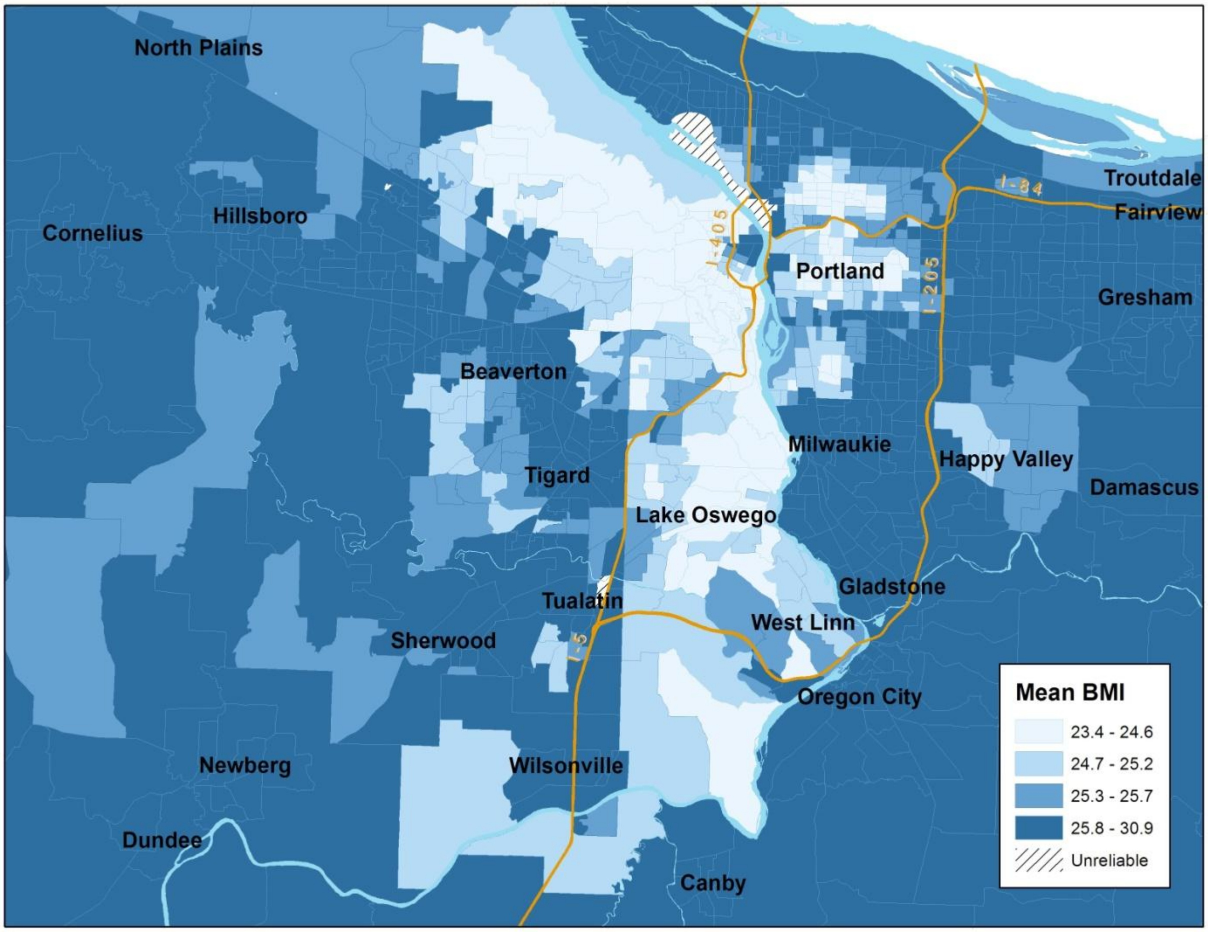
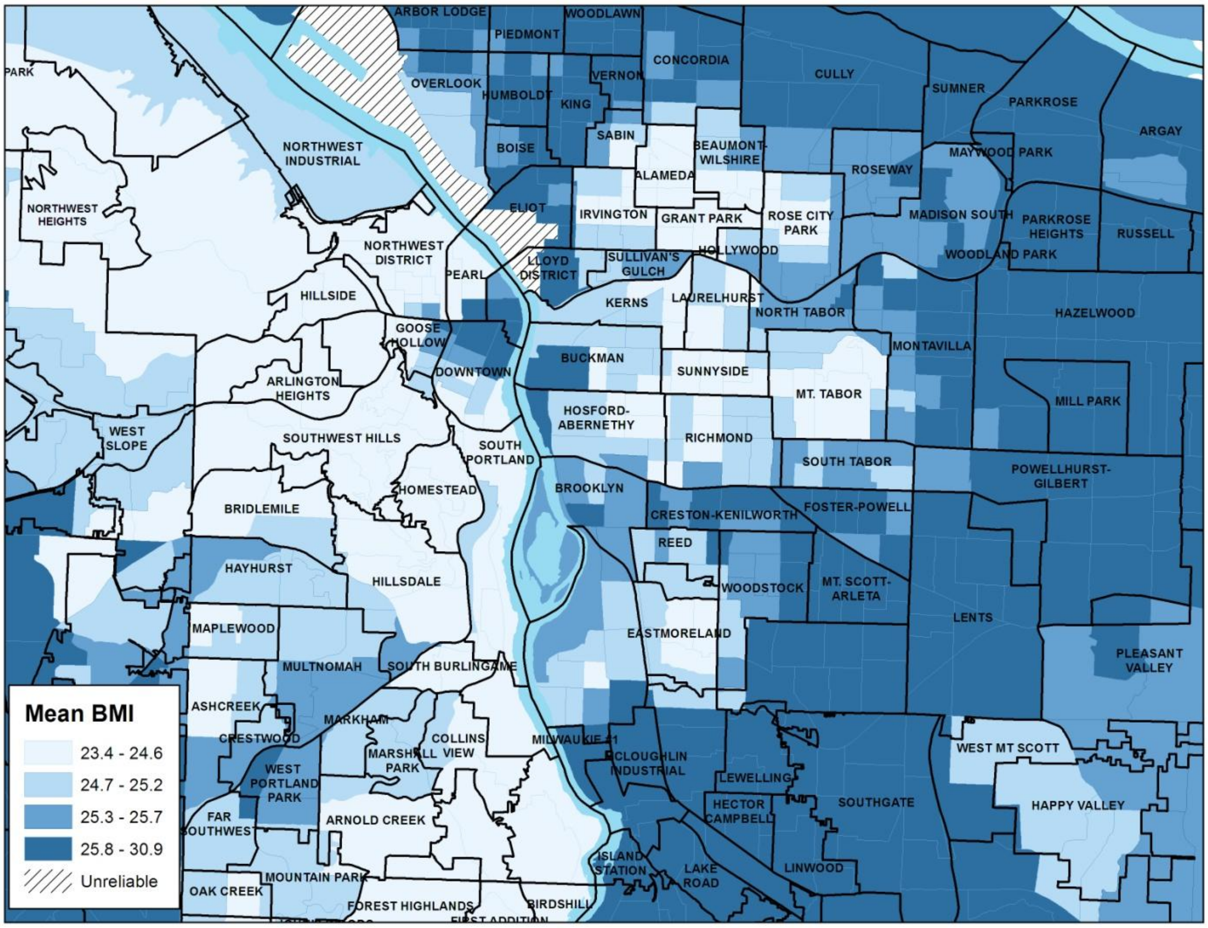


Figure 8 shows the same data as Figure 7, but zoomed in to the city of Portland. Neighborhood boundaries from Metro's Regional Land Information System (21) overlay the age-adjusted BMI estimates for block groups.

The area marked with cross-hatching is the Swan Island industrial zone. Central east side residential neighborhoods have lower BMIs, with BMI increasing towards the north, east and south. Neighborhoods in the West Hills also have lower BMIs.

This is the first time BMI estimates have been available for such small geographic areas in Oregon. Estimates show interesting variation at the community level and warrant further exploration. We anticipate these data will be very useful for guiding public health efforts and describing environmental influences on obesity.

Figure 8. Age-adjusted mean BMI by block group, Portland neighborhoods (outlined in black), from DMV records 2006-2010



Discussion

DMV records are a valuable resource for public health surveillance in Oregon. The Oregon DMV data set is of high quality, flexible, simple to use, inexpensive, and easy for the state public health agency to obtain. Data are representative of Oregon's population distribution, and the large sample size produces precise BMI estimates for small geographic areas. An 8-year renewal cycle means about one-eighth of the adults in the Oregon update their driver licenses and ID cards each year. The good data quality is a tribute to the quality control done by DMV employees. The low cost of the DMV data set made it accessible for public health surveillance in Oregon. We did not determine the costs to access DMV records in other states, but we recommend public health agencies contact their DMV to inquire.

Because height and weight data are self-reported, and anecdotal evidence suggests people may not update their weight when renewing a driver's license, we expected BMI estimates from DMV data would change more slowly than estimates from the BRFSS. However, we found the BMI estimates from DMV records tracked fairly well with the annual BRFSS estimates. This suggests DMV records and the BRFSS are comparably sensitive for describing change over time. The large sample size permitted trend analysis for specific birth cohorts, and provided evidence that the increase in BMI is leveling off. This finding warrants further exploration.

Consistent with prior studies (10,11), we found DMV data to underestimate mean BMI. The effect is more pronounced among women, due to greater differences in reported weights. Because of this bias, it may be best to analyze trends for men and women separately. Like Ossiander and colleagues, we found evidence that the greatest underestimation of weight occurs among the heaviest state residents (11). This may be due to systematic underreporting of weight, or because those people gained the most weight since getting their original license and are less likely to update their weight information. Whatever the reason, the bias creates obesity prevalence estimates that are very different from established state-level estimates. For this reason, we recommend using BRFSS estimates rather than DMV records to estimate obesity prevalence. DMV data are more suitable for describing spatial patterns across small areas. Data quality could be improved by putting rulers and scales in the DMV offices, and requiring updated height and weight information for all renewals.

We did identify some peculiarities with the DMV records. In a snapshot of the DMV database, there were more records for adults age 18-84 issued between 2003 and 2010 than the 2010 Census population estimate for that age range; a study of driver license records in North Carolina had a similar finding (22). This is probably due to people moving out of state and the Oregon DMV not being notified (17). New license records for women had higher BMI values than renewals; the opposite was true for men. This finding is difficult to interpret. Linking archived versions of the DMV database to see how individuals' records changed over time would permit a more detailed investigation.

Regression analyses indicate the rate of increase of mean BMI is slowing; this finding is consistent with national trends (23). Though rates remain high, declines in obesity rates would be promising evidence that public health efforts are beginning to pay off. However, overall decreases may mask growing disparities in obesity prevalence. In the future, we plan to use DMV data to further describe BMI changes over time and to identify demographic and environmental factors associated with those changes.

Limitations

Our findings are based on Oregon DMV records and may not be applicable to other states. Cost and available data fields may vary widely, so we encourage state public health agencies to look into obtaining their state's DMV data for BMI surveillance. Even if states do not collect information on height or weight, DMV data may still be a valuable resource for public health. For instance, address information in DMV records can be used to identify populations exposed to environmental hazards. A recent study found 22 states (including Oregon) unwilling to provide DMV records for use recruiting participants in a cancer research study (4), but, as evidenced by our evaluation, those findings likely to do not apply to public health agencies doing surveillance work.

As of July 1, 2008, proof of U.S. citizenship or lawful presence in the country, proof of Social Security number and proof of full legal name were required to obtain or renew an Oregon driver license or ID card. These new requirements may have affected application and renewal rates beginning in 2008. Some groups may not be equally represented in the DMV data. People who are less likely to have a state-issued ID card, (such as the elderly, undocumented, institutionalized, low-income and those with mental illness) are underrepresented in these data. The current evaluation does not include youth under the age of 18, though many records for youth are included in the DMV dataset. Future studies could examine specific age groups in greater detail.

As people die or move out of state, older records in the DMV database may become less representative of the population at the time of the license issue. Therefore, it may be prudent to use only records issued in recent years for analysis. Archived snapshots of the DMV database from previous years are available and could be used to generate historical BMI estimates. We used data from a single snapshot of the DMV database for our analysis, but plan to repeat analyses using data compiled from snapshots from a range of years. We believe treating records issued each year as a sample of the population, and combining records from multiple archived snapshots, will produce a more accurate picture of change of time.

There are a number of reasons why adults would have an ID card instead of a driver license, including medical conditions that prevent them from driving. We were not able to distinguish driver licenses and ID cards in this evaluation because that data field was not requested. We recommend other state public health agencies work closely with their DMV offices to craft a data request, to ensure that all useful data elements are considered. Future studies could compare data from driver licenses and ID cards to see if there are differences between the groups.

Estimates for some block groups were marked unreliable because the software we used was unable to geocode enough addresses. Manually geocoding these excluded 40,000 records would be time-consuming, but would result in even better coverage of the state.

Our findings are based on analysis of Oregon DMV records and may not apply to other states and territories. We recommend a national assessment be done to determine the accessibility, cost, and available data in DMV records. Such a study would provide meaningful guidance to public health agencies.

Next steps

Our evaluation points to a number of areas for future study. More work is needed to explore the limits of the data, especially with regard to geographic resolution. We are now working to acquire archived DMV records from the Oregon Department of Transportation, so that we will have the most representative data from each year to analyze. From these data we plan to analyze trends in mean BMI, identifying populations that have seen the most and least change over time. We will use this information to describe demographics and community conditions related to obesity in Oregon.

Oregon is the first state to use DMV records for BMI surveillance, but we anticipate other states will be exploring this data source as well. Developing standards for geospatial analysis of DMV data would benefit public health agencies and facilitate multi-state studies. A national database of standardized, age-adjusted BMI estimates for small geographic areas would be a tremendous resource for studying environmental influences on obesity and enhancing the ability of public health agencies and advocates to engage in obesity prevention. The Centers for Disease Control and Prevention could be a leader in this effort. We encourage the National Environmental Public Health Tracking Network to take on this initiative in collaboration with the National Center for Chronic Disease Prevention and Health Promotion.

Conclusions

Oregon's DMV database is a vast, inexpensive, flexible source of data for obesity surveillance. BMI estimates from DMV records are more conservative than estimates from the BRFSS, but reveal striking patterns over small geographic areas. We anticipate DMV data will be a great resource for public health advocates and practitioners in Oregon and throughout the nation. We strongly encourage other state public health agencies to explore using DMV records for obesity surveillance.

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Appendix A. Availability of weight information on driver licenses and ID cards

States and territories that have height and weight on driver licenses and ID cards (n=39)

Alabama	Indiana	Ohio
Alaska	Kansas	Oklahoma
American Samoa	Louisiana	Oregon
Arizona	Maine	Puerto Rico
California	Maryland	Rhode Island
Colorado	Minnesota	South Carolina
Delaware	Mississippi	South Dakota
District of Columbia	Missouri	Utah
Georgia	Montana	Vermont
Guam	Nebraska	Washington
Hawaii	Nevada	West Virginia
Idaho	New Mexico	Wisconsin
Illinois	Northern Mariana Islands	Wyoming

States and territories that have only height on driver licenses and ID cards (n=17)

Arkansas	Michigan	Pennsylvania
Connecticut	New Hampshire	Tennessee
Florida	New Jersey	Texas
Iowa	New York	U.S. Virgin Islands
Kentucky	North Carolina	Virginia
Massachusetts	North Dakota	

Data source: I.D. Checking Guide 2012. Drivers License Guide Company, Redwood City, CA.

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