

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/331440009>

# Blood pressure and hypertension

**Article** in Health reports / Statistics Canada, Canadian Centre for Health Information = Rapports sur la santé / Statistique Canada, Centre canadien d'information sur la santé · February 2019

DOI: 10.25318/82-003-x201900200002

---

CITATIONS

69

---

READS

26,664

5 authors, including:



**Jason Deguire**

Statistics Canada

16 PUBLICATIONS 323 CITATIONS

SEE PROFILE



**Janine Clarke**

Statistics Canada

38 PUBLICATIONS 6,820 CITATIONS

SEE PROFILE



**Tracey Bushnik**

Statistics Canada

59 PUBLICATIONS 1,828 CITATIONS

SEE PROFILE

## Health Reports

# Blood pressure and hypertension

by Jason DeGuire, Janine Clarke, Kaitlyn Rouleau, Joel Roy, and  
Tracey Bushnik

Release date: February 20, 2019



Statistics  
Canada

Statistique  
Canada

Canada

---

## How to obtain more information

For information about this product or the wide range of services and data available from Statistics Canada, visit our website, [www.statcan.gc.ca](http://www.statcan.gc.ca).

You can also contact us by

**email at** [STATCAN.infostats-infostats.STATCAN@canada.ca](mailto:STATCAN.infostats-infostats.STATCAN@canada.ca)

**telephone**, from Monday to Friday, 8:30 a.m. to 4:30 p.m., at the following numbers:

- |   |                |
|---|----------------|
| • Statistical Information Service                             | 1-800-263-1136 |
| • National telecommunications device for the hearing impaired | 1-800-363-7629 |
| • Fax line  | 1-514-283-9350 |

### Depository Services Program

- |                  |                |
|------------------|----------------|
| • Inquiries line | 1-800-635-7943 |
| • Fax line       | 1-800-565-7757 |

## Standards of service to the public

Statistics Canada is committed to serving its clients in a prompt, reliable and courteous manner. To this end, Statistics Canada has developed standards of service that its employees observe. To obtain a copy of these service standards, please contact Statistics Canada toll-free at 1-800-263-1136. The service standards are also published on [www.statcan.gc.ca](http://www.statcan.gc.ca) under “Contact us” > [“Standards of service to the public.”](#)

## Note of appreciation

Canada owes the success of its statistical system to a long-standing partnership between Statistics Canada, the citizens of Canada, its businesses, governments and other institutions. Accurate and timely statistical information could not be produced without their continued co-operation and goodwill.

Published by authority of the Minister responsible for Statistics Canada

© Her Majesty the Queen in Right of Canada as represented by the Minister of Industry, 2019

All rights reserved. Use of this publication is governed by the Statistics Canada [Open Licence Agreement](#).

An [HTML version](#) is also available.

*Cette publication est aussi disponible en français.*

---

# Blood pressure and hypertension

by Jason DeGuire, Janine Clarke, Kaitlyn Rouleau, Joel Roy, and Tracey Bushnik

## Abstract

**Background:** Hypertension, or high blood pressure, is a major cause of disability and the leading risk factor for death around the world. Ongoing surveillance is necessary to monitor and assess the population burden of hypertension in Canada.

**Data and methods:** Using measured data from the Canadian Health Measures Survey, this analysis estimates average systolic blood pressure (BP), average diastolic BP, and hypertension prevalence, awareness, treatment and control in the population aged 20 to 79 years in the period from 2012 to 2015 by sex and age group. Crude and age-standardized overall estimates for 2007-2009, 2009-2011, 2012-2013 and 2014-2015 are also presented.

**Results:** Among adults aged 20 to 79 years, 24% of males and 23% of females had hypertension, defined as measured BP  $\geq 140/90$  mm Hg or past-month use of antihypertensive medication. Hypertension prevalence increased to 40% for males and 32% for females when the BP threshold was lowered to  $\geq 130/80$  mm Hg. Among adults, 84% of people with hypertension were aware of their condition, 80% of hypertensive people were treated for their condition, and 66% had controlled hypertension (measured BP  $< 140/90$  mm Hg), though those aged 20 to 39 were less likely than older age groups to be aware, treated or controlled. Crude and age-standardized rates remained fairly stable during the period from 2007-2009 to 2014-2015.

**Interpretation:** Hypertension prevalence among adults has remained stable over time in Canada, and hypertension awareness, treatment and control have remained high. However, rates of awareness, treatment and control are lower among younger adults. This finding highlights the importance of initiatives to encourage this population to have their blood pressure checked and treated.

**Keywords:** Blood pressure, hypertension, prevalence, awareness, control

**DOI:** <https://www.doi.org/10.25318/82-003-x201900200002>

Hypertension, or high blood pressure, is a leading contributor to disability-adjusted life years.<sup>1</sup> Canada's reported rates of hypertension awareness, treatment and control are some of the highest in the world.<sup>2</sup> This has been attributed to several factors, including the efforts of health care organizations and professionals to reduce the burden of hypertension, and the efficacy of knowledge translation about hypertension and its risks.<sup>3</sup> Despite these efforts, hypertension affected almost 1 in 4 Canadian adults in 2012-2015<sup>4</sup> and is currently ranked as the leading risk factor for death globally.<sup>5</sup> In 2010, the costs attributable to hypertension in Canada were estimated at \$13.9 billion, and are forecasted to increase to \$20.5 billion by 2020.<sup>6</sup> Ongoing surveillance is necessary to monitor and assess the population burden of hypertension in Canada.

Using the most recent data (2012-2015) from the Canadian Health Measures Survey (CHMS), this study examines systolic blood pressure (SBP), diastolic blood pressure (DBP), and hypertension prevalence, awareness, treatment and control estimates for adults aged 20 to 79 by age group and sex. Hypertension is defined using two sets of blood pressure thresholds: SBP  $\geq 140$  mm Hg or DBP  $\geq 90$  mm Hg;<sup>7</sup> and SBP  $\geq 130$  mm Hg or DBP  $\geq 80$  mm Hg (as per American College of Cardiology (ACC) and American Heart Association (AHA) 2017 guidelines.<sup>8</sup> To assess trends over time, crude and age-standardized estimates of SBP, DBP, and hypertension prevalence, awareness, treatment and control are also presented for adults aged 20 to 79 in 2007-2009, 2009-2011, 2012-2013 and 2014-2015.

## Methods

### Data source

The data are from the CHMS, a nationally representative health survey. The CHMS covers 96% of the Canadian population aged 3 to 79. It excludes people living in the territories, people living on reserves and in other Aboriginal settlements, full-time members of the Canadian Forces, institutionalized individuals, and residents of certain remote areas.<sup>9,10</sup>

Data collection takes place in two parts: at an in-person interview in the home, where information is collected on health-related risk factors, health conditions and medication use; and a subsequent visit to a mobile examination centre (MEC), where direct physical measurements, including blood pressure, are taken ([www.statcan.gc.ca/chms](http://www.statcan.gc.ca/chms)). To produce estimates by sex and age group for the 2012-2015 reference period, cycles 3 (2012-2013) and 4 (2014-2015) were combined, for a total of 6,357 adults aged 20 to 79. Pregnant women ( $n = 43$ ) and those with incomplete blood pressure data ( $n = 20$ ) were excluded. The final analytical sample size was 6,294.

For comparisons over time, results based on the same exclusion criteria are also presented for each individual survey cycle. The final sample was 3,487 in cycle 1 (2007-2009), 3,618 in cycle 2 (2009-2011), 3,158 in cycle 3 (2012-2013), and 3,136 in cycle 4 (2014-2015).<sup>9-12</sup>

### Measures and definitions

**Blood pressure.** SBP and DBP measurements using the BpTRU™ BPM-300 (BpTRU Medical Devices Ltd., Coquitlam, British Columbia) were taken at the MEC. The mid-arm circum-

ference was measured for cuff placement, and the appropriate cuff size was used. The device takes six readings for each participant, and the last five are averaged to determine SBP and DBP levels.<sup>13</sup>

**Hypertensive<sub>140/90</sub>** Respondents were considered hypertensive if SBP  $\geq$  140 mm Hg or DBP  $\geq$  90 mm Hg or if they reported antihypertensive medication use in the past month.

**Hypertensive<sub>130/80</sub>** Respondents were considered hypertensive if SBP  $\geq$  130 mm Hg or DBP  $\geq$  80 mm Hg or if they reported antihypertensive medication use in the past month.

**Isolated systolic hypertension** is defined as the proportion of people with hypertension who have measured SBP  $\geq$  140 mm Hg and measured DBP < 90 mm Hg.

**Awareness (of hypertension)** was defined as a hypertensive<sub>140/90</sub> respondent's report of either diagnosed hypertension or antihypertensive medication use in the past month.

**Treatment (of hypertension)** was defined as a hypertensive<sub>140/90</sub> respondent's report of antihypertensive medication use in the past month.

**Controlled (hypertension)** was defined as a hypertensive<sub>140/90</sub> respondent's report of antihypertensive medication use in the past month together with a measured mean SBP < 140 mm Hg and DBP < 90 mm Hg.

**Antihypertensive medication use** refers to the medications recorded during the household and clinic interviews assigned to the following Anatomical Therapeutic Classification (ATC) codes: C02 (excluding C02KX01); C03 (excluding C03BA08 and C03CA01); C07 (excluding C07AA07, C07AA12 and C07AG02); C08; and C09.

**Table 1**

**Average systolic and diastolic blood pressure (mm Hg), by sex and age group, household population aged 20 to 79 years, Canada, combined 2012 to 2015**

	Both sexes													
	n	Mean	95% confidence interval		SD	P50	(Q1,Q3)	n	Mean	95% confidence interval		SD	P50	(Q1,Q3)
			from	to						from	to			
	Systolic blood pressure, mm Hg							Diastolic blood pressure, mm Hg						
Overall (crude)	6294	113	112	114	16	111	(102,121)	6294	72	72	73	10	71	(65,78)
Overall (age-standardized)	6294	111	111	112	...	...	...	6294	72	71	72	...	...	...
Age group														
20 to 39 years	2098	106*	105	107	11	105	(98,113)	2098	70	69	71	9	69	(63,75)
40 to 59 years	2141	114*	113	116	15	112	(104,122)	2141	74*	74	75	10	74	(67,79)
60 to 69 years	1344	120*	119	122	16	119	(109,129)	1344	73*	72	74	9	72	(66,78)
70 to 79 years†	711	126	124	128	18	124	(112,136)	711	70	69	71	10	69	(63,76)
	Males							Females						
	n	Mean	95% confidence interval		SD	P50	(Q1,Q3)	n	Mean	95% confidence interval		SD	P50	(Q1,Q3)
			from	to						from	to			
	Systolic blood pressure, mm Hg							Diastolic blood pressure, mm Hg						
Overall (crude)	3148	115	114	116	14	112	(105,122)	3146	112‡	110	113	17	108	(99,120)
Overall (age-standardized)	3148	114	113	115	...	...	...	3146	109	108	110	...	...	...
Age group														
20 to 39 years	1055	109*	108	111	10	109	(102,115)	1043	103*‡	101	105	11	100	(95,109)
40 to 59 years	1072	116*	115	118	14	114	(107,124)	1069	112*‡	110	114	16	110	(100,119)
60 to 69 years	712	120	118	122	15	119	(110,129)	632	120*	119	122	16	118	(108,129)
70 to 79 years†	309	123	120	126	17	120	(110,134)	402	128‡	126	131	18	127	(115,139)
	Diastolic blood pressure, mm Hg													
Overall (crude)	3148	74	73	75	9	73	(67,79)	3146	70‡	69	71	9	69	(63,76)
Overall (age-standardized)	3148	74	73	74	...	...	...	3146	70	69	71	...	...	...
Age group														
20 to 39 years	1055	71	70	72	9	70	(65,77)	1043	68‡	67	70	8	67	(62,73)
40 to 59 years	1072	77*	76	78	9	76	(70,82)	1069	71‡	70	73	9	71	(65,77)
60 to 69 years	712	75*	74	76	9	74	(68,79)	632	71‡	70	72	9	70	(64,76)
70 to 79 years†	309	70	69	72	10	69	(64,76)	402	70	68	71	10	70	(63,76)

... not applicable

\*significantly different from reference category (p < 0.05)

‡reference category

‡females significantly different from males (p < 0.05)

**Notes:** Comparisons between estimates for males and females not done for age-standardized estimates.

**Source:** Statistics Canada, Canadian Health Measures Survey, combined 2012 to 2015.

**Age-standardized prevalence** represents the potential prevalence of hypertension if the study population had had the same age distribution as a given standard population. Age standardization allows for comparisons of estimates by removing the influence of changes in the age distribution of the population.

## Analysis

Weighted estimates of mean SBP and DBP, and the prevalence of hypertension, hypertension awareness, treatment and control were calculated. Replicate weights generated by Statistics Canada were used to calculate variance estimation (95% confidence interval [CI]) and conduct significance testing. The appropriate survey weights and denominator

degrees of freedom were used to analyze the combined or individual cycles of data.<sup>9–12, 14</sup> The data were analyzed with SAS 9.3 and SUDAAN 11.0.

All estimates are presented as per the suggested standards of uniform reporting (crude, age-standardized, by age group) of hypertension in adults using population survey data.<sup>7</sup> The direct method was used to age-standardize estimates to the World Health Organization's world standard population.<sup>15</sup>

## Results

### Average systolic and diastolic blood pressure

Average SBP/DBP was 115/74 mm Hg in males aged 20 to 79 in 2012-2015

and 112/70 mm Hg in females aged 20 to 79 in the same period (Table 1). SBP and DBP varied by age group and sex. For both males and females, SBP increased with age, but the difference in SBP between the youngest and oldest age groups was much greater among females (25 mm Hg) than among males (14 mm Hg). Mean DBP was highest for middle-aged males (40 to 69 years) whereas females' mean DBP was fairly stable across all age groups. Neither the crude nor the age-standardized average SBP and DBP values for males and females changed significantly from 2007-2009 to 2012-2015 (Table 2). In 2012-2015, the prevalence of isolated systolic hypertension (ISH) was higher among females than among males (Figure 1). Males and

**Table 2**

**Average systolic and diastolic blood pressure, and hypertension prevalence, awareness, treatment and control, by sex, household population aged 20 to 79 years, Canada, 2007-2009, 2009-2011, 2012-2013, and 2014-2015**

Population aged 25 to 75 years, Canada, 2007-2009, 2009-2011, 2012-2013, and 2014-2015												
	Systolic blood pressure				Diastolic blood pressure				Prevalence			
	n	mean	95% confidence interval		n	mean	95% confidence interval		n	%	95% confidence interval	
			from	to			from	to			from	to
Both sexes												
Overall (crude)												
2007-2009†	3487	113	112	115	3487	72	71	73	946	21.2	19.5	23.1
2009-2011	3618	113	111	114	3618	72	71	73	931	23.5	20.7	26.5
2012-2013	3158	112	111	113	3158	71	70	72	838	23.2	20.6	26.1
2014-2015	3136	114	113	116	3136	73	72	74	818	23.2	20	26.8
Overall (age-standardized)												
2007-2009†	3487	112	111	113	3487	72	71	73	946	17.5	16.1	18.9
2009-2011	3618	111	109	112	3618	71	70	72	931	18.9	16.4	21.6
2012-2013	3158	110	109	111	3158	71	70	71	838	18.2	16.2	20.3
2014-2015	3136	113	111	114	3136	73	72	74	818	17.8	15.1	20.9
Males												
Overall (crude)												
2007-2009†	1650	115	114	116	1650	74	73	75	478	21.5	19.2	24.1
2009-2011	1683	115	113	117	1683	74	72	75	484	27.1*	22.4	32.5
2012-2013	1569	114	112	116	1569	74	72	75	415	23.3	20.3	26.6
2014-2015	1579	116	115	117	1579	75	74	76	446	24.3	20.8	28.3
Overall (age-standardized)												
2007-2009†	1650	114	113	116	1650	74	73	75	478	18.6	16.8	20.6
2009-2011	1683	114	112	116	1683	73	72	74	484	22.3	18.3	26.9
2012-2013	1569	113	111	114	1569	73	72	74	415	19.2	16.4	22.4
2014-2015	1579	115	114	116	1579	74	73	75	446	18.9	15.9	22.3
Females												
Overall (crude)												
2007-2009†	1837	111	110	113	1837	70	69	71	468	20.9	19.4	22.6
2009-2011	1935	110	109	112	1935	70	68	71	447	19.8	16.9	23.1
2012-2013	1589	110	109	112	1589	69	68	70	423	23.2	19.2	27.7
2014-2015	1557	113	111	115	1557	71	70	73	372	22	17.6	27.1
Overall (age-standardized)												
2007-2009†	1837	109	108	111	1837	70	69	70	468	16.5	15.3	17.8
2009-2011	1935	108	107	109	1935	69	68	70	447	15.6	13	18.5
2012-2013	1589	108	106	109	1589	68	67	69	423	17.2	14.4	20.3
2014-2015	1557	111	109	113	1557	71	69	73	372	16.8	13.5	20.8

Table 2

**Average systolic and diastolic blood pressure, and hypertension prevalence, awareness, treatment and control, by sex, household population aged 20 to 79 years, Canada, 2007-2009, 2009-2011, 2012-2013, and 2014-2015**

	Awareness				Treatment				Control			
	n	%	95% confidence interval		n	%	95% confidence interval		n	%	95% confidence interval	
			from	to			from	to			from	to
Both sexes												
Overall (crude)												
2007-2009†	793	85.2	81.5	88.3	764	81.7	77.6	85.2	630	68.6	64.3	72.6
2009-2011	785	84.3	79.4	88.1	759	80.1	73.6	85.4	634	66.5	58.9	73.3
2012-2013	735	86.8	80.9	91.1	703	81.0	73.7	86.7	593	69.1	62.6	74.9
2014-2015	683	81.7	76.5	86	651	78.1	69.7	84.6	534	62.9	56.1	69.3
Overall (age-standardized)												
2007-2009†	793	73.8	59.3	84.5	764	67.5	54.7	78.2	630	60	47.3	71.5
2009-2011	785	66.1	48.1	80.4	759	61.3	42.6	77.1	634	54.5	35.9	71.9
2012-2013	735	72.5	61.9	81.1	703	64.2	48.1	77.5	593	56.7	42	70.3
2014-2015	683	79.2	73	84.2	651	73.7	63.1	82.1	534	61.8	53.1	69.8
Males												
Overall (crude)												
2007-2009†	386	82.5	77.5	86.5	367	78.4	73.9	82.3	318	69.6	63.8	74.8
2009-2011	407	84.6	76.4	90.2	389	78.2	67.2	86.2	331	65.3	53.8	75.3
2012-2013	368	90.7*	85.2	94.2	346	81.2	69.6	89.1	299	69.6	54.9	81.2
2014-2015	365	78.9	69.3	86.1	351	76.6	63.3	86.1	297	62.7	54.2	70.5
Overall (age-standardized)												
2007-2009†	386	68.7	47.7	84.1	367	60.8	44.2	75.3	318	55.6	41.3	68.9
2009-2011	407	68.9	52.8	81.5	389	60.2	41.6	76.2	331	53.6	35	71.3
2012-2013	368	74.2	55.5	86.9	346	66.7	52.1	78.7	299	62.5	47.1	75.6
2014-2015	365	72.4	60.8	81.6	351	65.7	52.1	77.2	297	53.9	45.3	62.2
Females												
Overall (crude)												
2007-2009†	407	88.1	83.4	91.6	397	85.1	79.6	89.2	312	67.6	61.8	72.9
2009-2011	378	83.9	77	89	370	82.8	76.4	87.7	303	68.1	60.2	75
2012-2013	367	82.9	72.8	89.8	357	80.9	71.8	87.5	294	68.6	61.2	75.1
2014-2015	318	84.9	79.2	89.2	300	79.8	72	85.8	237	63.2	55.2	70.4
Overall (age-standardized)												
2007-2009†	407	83.8	69.9	92	397	81.4	69.1	89.5	312	68.4	50.6	82.1
2009-2011	378	75.8	62	85.7	370	75.2	61.7	85.1	303	67.3	50.6	80.5
2012-2013	367	68.5	51.5	81.7	357	57.0	40.8	71.8	294	46.2	36.1	56.5
2014-2015	318	87.5	79.5	92.6	300	83.3	70.5	91.3	237	72.5	62.4	80.7

\*significantly different from reference category ( $p < 0.05$ )

<sup>†</sup>reference category

**Notes:** Respondents were considered hypertensive if SBP  $\geq 140$  mm Hg or DBP  $\geq 90$  mm Hg or if they reported antihypertensive medication use in the past month. Awareness (of hypertension) was defined as a hypertensive (140/90) respondent's report of either diagnosed hypertension or antihypertensive medication use in the past month. Treatment (of hypertension) was defined as a hypertensive (140/90) respondent's report of antihypertensive medication use in the past month. Controlled (hypertension) was defined as a hypertensive respondent's report of antihypertensive medication use in the past month together with measured mean SBP  $< 140$  mm Hg and DBP  $< 90$  mm Hg.

**Source:** Statistics Canada, Canadian Health Measures Survey, cycle 1 (2007-2009), cycle 2 (2009-2011), cycle 3 (2012-2013) and cycle 4 (2014-2015).

females aged 70 to 79 had a higher prevalence of ISH than younger age groups.

## Hypertension prevalence

In 2012-2015, nearly 1 in 4 males (24%) and females (23%) aged 20 to 79 had hypertension<sub>140/90</sub> (Table 3). The prevalence of hypertension<sub>140/90</sub> increased significantly with age. Males (71%) and females (69%) aged 70 to 79 were about three times as likely to be categorized as hypertensive<sub>140/90</sub> as males (25%) and females (21%) aged 40 to 59. From

2007-2009 to 2012-2015, the prevalence of hypertension<sub>140/90</sub> among 20- to 79-year-olds remained fairly stable, at about 23% (crude) or 18% (age-standardized) (Table 2).

Applying the 130/80 mm Hg threshold (hypertension<sub>130/80</sub>) to categorize people as hypertensive<sup>8</sup> resulted in a significant increase in the overall prevalence of hypertension among both sexes and all age groups (Figure 2). Specifically, 40% of males had hypertension<sub>130/80</sub>; this is 16 percentage points higher than the prevalence of hypertension<sub>140/90</sub>. Among

females, the prevalence of hypertension<sub>130/80</sub> was nine percentage points higher than the prevalence of hypertension<sub>140/90</sub>. The largest relative difference in prevalence was observed among those aged 20 to 39 (3% to 15%, sexes combined).

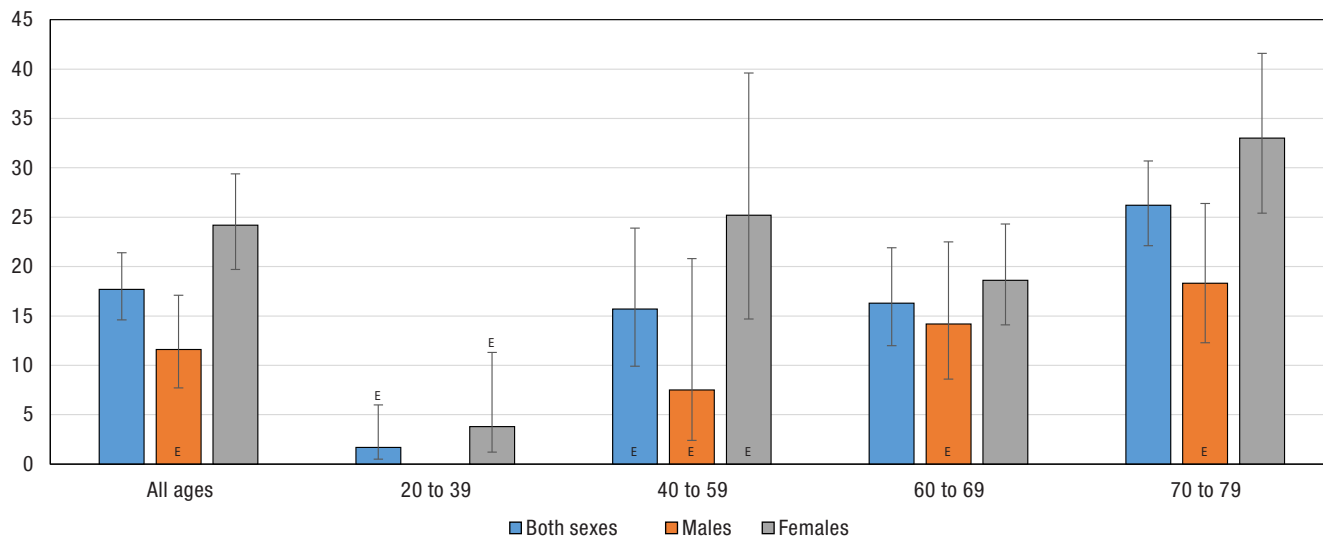
## Hypertension awareness, treatment and control

Eighty-four percent of those aged 20 to 79 with hypertension<sub>140/90</sub> were aware of their condition (Table 3). However,



**Figure 1**  
**Proportion of hypertensive adults with isolated systolic hypertension, by sex and age group, household population aged 20 to 79 years, Canada, combined 2012 to 2015**

percent

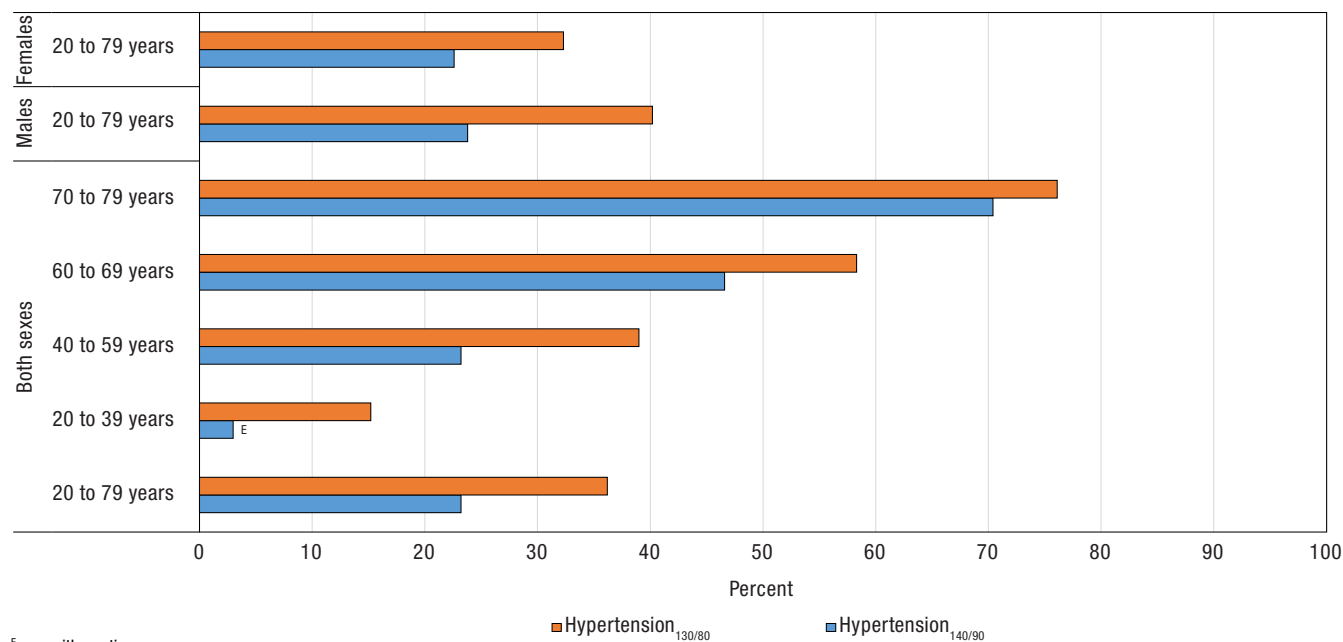


E use with caution

**Notes:** Respondents were considered hypertensive if SBP  $\geq 140$  mm Hg or DBP  $\geq 90$  mm Hg or if they reported antihypertensive medication use in the past month. Isolated systolic hypertension is presented as the proportion of people with hypertension who have measured SBP  $\geq 140$  mm Hg and measured DBP  $< 90$  mm Hg.

**Source:** Statistics Canada, Canadian Health Measures Survey, combined 2012 to 2015.

**Figure 2**  
**Prevalence of hypertension<sub>130/80</sub> and hypertension<sub>140/90</sub> by sex and age group, household population aged 20 to 79 years, Canada, combined 2012 to 2015**



E use with caution

**Notes:** Hypertension<sub>140/90</sub> is defined as SBP  $\geq 140$  mm Hg or DBP  $\geq 90$  mm Hg self-reported, or antihypertensive medication use in the past month. Hypertension<sub>130/80</sub> is defined as systolic blood pressure (SBP) of 130 to 139 mm Hg or diastolic blood pressure (DBP) of 80 to 89 mm Hg, as per the American College of Cardiology and the American Heart Association 2017 guidelines.

**Source:** Statistics Canada, Canadian Health Measures Survey, combined 2012 to 2015.



Table 3

Hypertension prevalence, awareness, treatment and control, by sex and age group, household population aged 20 to 79 years, Canada, combined 2012 to 2015

	Prevalence				Awareness				Treatment				Control			
	n	%	95% confidence interval		n	%	95% confidence interval		n	%	95% confidence interval		n	%	95% confidence interval	
			from	to			from	to			from	to			from	to
<b>Both sexes</b>																
Overall (crude)	1656	23.2	21.2	25.3	1418	84.2	80.7	87.3	1354	79.5	74.3	83.9	1127	66	61.5	70.2
Overall (age-standardized)	1656	18.1	16.5	19.8	1418	77.3	68.6	84.2	1354	69.1	53.7	81.1	1127	61.7	46.2	75.1
Age group (y)																
20 to 39 years	93	3 <sup>E*</sup>	1.9	4.8	63	64.6 <sup>E*</sup>	40.4	83.1	50	55.4 <sup>E*</sup>	36.2	73.1	43	51.2 <sup>E</sup>	34	68
40 to 59 years	404	23.2 <sup>*</sup>	19.4	27.4	322	79.7	70.1	86.8	300	72.5 <sup>*</sup>	61.5	81.3	255	59.5	50.3	68
60 to 69 years	655	46.6 <sup>*</sup>	42.4	50.9	579	88.9	84.3	92.2	559	85	77.9	90.2	477	73.8	67.9	79
70 to 79 years <sup>†</sup>	504	70.4	65.2	75.1	454	89.5	85.2	92.6	445	88.5	84.4	91.7	352	69.2	64.2	73.8
<b>Males</b>																
Overall (crude)	861	23.8	21.6	26.3	733	84.6	79.3	88.7	697	78.8	70.5	85.3	596	66	58.2	73.1
Overall (age-standardized)	861	19.2	17.2	21.3	733	77.8	62.6	88	697	70.8	55.6	82.4	596	64	50	76
Age group (y)																
20 to 39 years	53	3.3 <sup>E*</sup>	2.1	5.1	35	61.8 <sup>E</sup>	29.5	86.2	26	47.5 <sup>E*</sup>	22.8	73.5	24	44.7 <sup>E*</sup>	21.4	70.5
40 to 59 years	227	25 <sup>*</sup>	20.3	30.4	172	81	67.4	89.7	155	70.5 <sup>*</sup>	54.7	82.6	131	55.3 <sup>*</sup>	42	67.8
60 to 69 years	354	48 <sup>*</sup>	43.3	52.9	315	88.1	80.1	93.2	308	86.2	77.3	92	266	76.7	68.3	83.4
70 to 79 years <sup>†</sup>	227	71.4	64.8	77.3	211	91.7	82.9	96.1	208	91.1	82.6	95.7	175	75.9	67.5	82.7
<b>Females</b>																
Overall (crude)	795	22.6	19.7	25.7	685	83.9	78.8	87.9	657	80.3	75.1	84.6	531	65.9	61.1	70.4
Overall (age-standardized)	795	17.1	15	19.4	685	75.7	58.3	87.4	657	63.8	51.8	74.3	531	55.3	41.5	68.4
Age group (y)																
20 to 39 years	40	2.8 <sup>E*</sup>	1.2	6.2	28	68.1 <sup>E</sup>	34.9	89.5	24	65.2 <sup>E</sup>	33.8	87.3	19	59.1 <sup>E</sup>	31.4	82.1
40 to 59 years	177	21.3 <sup>*</sup>	16.1	27.7	150	78.2	64.1	87.8	145	74.8	60.6	85.1	124	64.3	52.3	74.8
60 to 69 years	301	45.2 <sup>*</sup>	39.8	50.8	264	89.6	84.8	93.1	251	83.8	74.8	90	211	70.8	64.4	76.5
70 to 79 years <sup>†</sup>	277	69.5	60.4	77.3	243	87.6	80.4	92.4	237	86.4	79.1	91.4	177	63.4	54.9	71.2

<sup>E</sup>use with caution

<sup>\*</sup>significantly different from reference category ( $p < 0.05$ )

<sup>†</sup>reference category

**Notes:** Respondents were considered hypertensive if SBP  $\geq 140$  mm Hg or DBP  $\geq 90$  mm Hg or if they reported antihypertensive medication use in the past month. Awareness (of hypertension) was defined as a hypertensive (140/90) respondent's report of either diagnosed hypertension or antihypertensive medication use in the past month. Controlled (hypertension) was defined as a hypertensive respondent's report of antihypertensive medication use in the past month together with measured mean SBP  $< 140$  mm Hg and DBP  $< 90$  mm Hg.

**Source:** Statistics Canada, Canadian Health Measures Survey, combined 2012 to 2015.

people aged 20 to 39 were much less likely to be aware of being hypertensive<sub>140/90</sub> (65%) than those in the older age groups. About 80% of those aged 20 to 79 with hypertension<sub>140/90</sub> reported being treated for their condition, and 66% of those with hypertension<sub>140/90</sub> had their hypertension<sub>140/90</sub> controlled (Table 3). As was the case with awareness, those in the youngest age group were less likely to be treated (55%) or to have their hypertension<sub>140/90</sub> controlled (51%). There was little difference between males and females in the overall crude estimates of awareness, treatment and control (Table 3), and little change from 2007-2009 to 2014-2015 (Table 2).

## Discussion

This study found that, in the period from 2012 to 2015, nearly 1 in 4 Canadian males and females aged 20 to 79 had hypertension<sub>140/90</sub>, when defined as measured BP higher than 140/90 mm Hg or past-month use of anti-hypertensive medication. Though measurement variation across devices makes direct comparisons difficult,<sup>16-18</sup> these rates are lower than those reported in other high-income countries where BP was also measured using an automated device.<sup>19</sup> The present study also found that the crude and age-standardized prevalence of hypertension<sub>140/90</sub> remained fairly stable from 2007-2009 to 2014-2015, a finding consistent with recent results from the United States.<sup>20</sup>

This study also found that people aged 70 to 79, particularly women, were

much more likely to have isolated systolic hypertension (ISH) than other age groups. ISH among older people is relatively common,<sup>21</sup> and is due to reduced elasticity of large arteries, long-term build-up of plaque, and increased incidence of cardiac and vascular disease.<sup>22</sup> Some studies suggest that higher prevalence among older women than among older men may be related to the hormonal changes that occur during menopause.<sup>23</sup>

Recently, the ACC/AHA Task Force on Clinical Practice Guidelines recommended a new, lower threshold of 130/80 mm Hg for hypertension,<sup>8</sup> further to evidence suggesting a gradient of increased cardiovascular disease risk for SBP and DBP levels above 120/80 mm Hg. Applying this revised threshold to the study population increased the overall prevalence of hypertension, with

the largest relative increase observed among those aged 20 to 39. Also, 2011 to 2014 data from the National Health and Nutrition Examination Survey (NHANES) in the United States showed that the youngest age group (20 to 44) had the greatest increase in hypertension prevalence after application of the new threshold.<sup>8</sup>

Diagnosis and awareness of hypertension are essential to manage and control blood pressure.<sup>24</sup> This study found that just over 4 out of 5 people with hypertension<sub>140/90</sub> were aware of their condition. This rate was fairly stable from 2007-2009 to 2014-2015, and remained significantly higher than the prevalence of awareness reported in other high-income countries during this period.<sup>19</sup> However, the results also show that those aged 20 to 39 were much less likely to be aware of being hypertensive<sub>140/90</sub> than people in the older age groups. This lack of awareness among younger people has been reported in the United States<sup>24</sup> and elsewhere,<sup>25, 26</sup> and highlights the importance of initiatives that encourage this population to get their blood pressure checked.<sup>27</sup>

As was the case for awareness, this study found that rates of treatment and control did not change significantly in Canada from 2007-2009 to 2014-2015. In general, treatment rates in Canada were considerably higher than those reported in other high-income coun-

tries.<sup>19</sup> Hypertension<sub>140/90</sub> control rates were also higher in Canada than in other countries,<sup>19</sup> particularly the United States, where less than half of those with hypertension<sub>140/90</sub> had measured BP lower than 140/90 mm Hg.<sup>20</sup> Canada's high rates of awareness, treatment and control have been attributed to several factors, including the concerted efforts of health care organizations and professionals to reduce the burden of hypertension, and effective knowledge translation about hypertension and its risks.<sup>3</sup> However, this study found that treatment and control rates were lower among the youngest age group, particularly among males. The lower rates for younger people could be associated with their fewer interactions with the health care system.<sup>28</sup> This suggests that initiatives encouraging blood pressure assessment for this population may be more appropriate outside formal health care channels.<sup>29</sup>

This study has several strengths. The CHMS is a population-based study with a large sample size, and blood pressure was measured objectively using an automated device with high quality control. However, the CHMS response rate for each cycle was from 52% to 55%. Although applying survey weights helps to ensure that the sample is representative of the target population, bias might exist if non-respondents differed systematically from respondents.

## Conclusion

This report provides an update on measured SBP, DBP, and hypertension prevalence, awareness, treatment and control in Canada. From 2007-2009 to 2012-2015, blood pressure levels and hypertension<sub>140/90</sub> prevalence remained stable among Canadian adults aged 20 to 79. Isolated systolic hypertension is approximately twice as prevalent among females as among males. Applying a new, lower BP threshold increased hypertension prevalence significantly among both males and females aged 20 to 79. While Canadians in general had high levels of awareness, treatment and control of hypertension<sub>140/90</sub>, this analysis highlighted that younger males are less likely to be aware of their hypertension<sub>140/90</sub> and less likely to be treated and controlled. Ongoing surveillance of blood pressure in Canada is necessary to accurately quantify the population burden of hypertension and to identify population groups that may be at higher risk of adverse outcomes. ■

## Acknowledgement

The authors thank Deirdre Hennessy for her expert advice throughout the research process.

## References

1. GBD 2015. Risk factors collaborators. Global, regional, and national comparative risk assessment of 79 behavioral, environmental and occupational, and metabolic risks or clusters of risks, 1990-2015: a systematic analysis for the global burden of disease study 2015. *Lancet* 2016; 388:1659-1724.
2. McAllister FA, Wilkins K, Joffres M, et al. Changes in the rates of awareness, treatment and control of hypertension in Canada over the past two decades. *Canadian Medical Association Journal* 2011; 183(9): 1007-1013.
3. Campbell NR, Feldman RD. Hypertension in Canada and the global context. The wine is vintage and the glass is two-thirds full, but is the bottle empty? *Canadian Journal of Cardiology* 2016; 32(5): 609-611.
4. Padwal RS, Bienek A, McAllister FA, Campbell NR. Epidemiology of hypertension in Canada: an update. *Canadian Journal of Cardiology* 2016; 32(5): 687-694.
5. Forouzanfar MH, Liu P, Roth GA, et al. Global burden of hypertension and systolic blood pressure of at least 110 to 115 mm Hg, 1990-2015. *The Journal of the American Medical Association* 2017; 317(2): 165-182.
6. Weaver CG, Clement FM, Campbell NR, et al. Health care costs attributable to hypertension: a Canadian population-based cohort study. *Hypertension* 2015; 66(3): 502-508.
7. Gee ME, Campbell N, Sarrafzadegan N, et al. Standards for the uniform reporting of hypertension in adults using population survey data: recommendations from the World Hypertension League Expert Committee. *The Journal of Clinical Hypertension* 2014; 16(11): 773-781.

8. Whelton PK, Carey RM, Aronow WS, et al. [ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA Guideline for the prevention, detection, evaluation, and management of high blood pressure in adults](#). *Hypertension* 2017; HYP.0000000000000065. Available at: <https://doi.org/10.1161/HYP.0000000000000065>. Accessed March 26, 2018.
9. [Statistics Canada. Canadian Health Measures Survey \(CHMS\) Data User Guide: Cycle 3 November 2014](#) 2014a. Available at: [http://www23.statcan.gc.ca/imdb-bmdi/document/5071\\_D4\\_T9\\_V2-eng.htm](http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V2-eng.htm)
10. Statistics Canada. [Canadian Health Measures Survey \(CHMS\) Data User Guide: Cycle 4](#). April 2017. Available by request at: [http://www23.statcan.gc.ca/imdb-bmdi/document/5071\\_D4\\_T9\\_V2-eng.htm](http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V2-eng.htm)
11. Statistics Canada. [Canadian Health Measures Survey \(CHMS\) Data User Guide: Cycle 1](#). Available at: [http://www23.statcan.gc.ca/imdb-bmdi/document/5071\\_D2\\_T1\\_V1-eng.pdf](http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D2_T1_V1-eng.pdf). Accessed April 20, 2018.
12. Statistics Canada. [Canadian Health Measures Survey \(CHMS\) Data User Guide: Cycle 2 November 2014](#) 2014a. Available at: [http://www23.statcan.gc.ca/imdb-bmdi/document/5071\\_D4\\_T9\\_V2-eng.htm](http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V2-eng.htm)
13. Bryan S, St-Pierre Larose M, Campbell N, et al. Resting blood pressure and heart rate measurement in the Canadian Health Measures Survey, Cycle 1. *Health Reports* 2010; 21(1): 71-78.
14. Statistics Canada. [Instructions for Combining Multiple Cycles of Canadian Health Measures Survey \(CHMS\) Data](#). Ottawa: Statistics Canada, 2017. Available by request at: [http://www23.statcan.gc.ca/imdb-bmdi/document/5071\\_D4\\_T9\\_V2-eng.htm](http://www23.statcan.gc.ca/imdb-bmdi/document/5071_D4_T9_V2-eng.htm)
15. Ahmad OB, Boschi-Pinto C, Lopez AD, et al. [Age standardization of rates: A new WHO standard. GPE Discussion Paper Series No 31. 2001](#). Available at: <http://www.who.int/healthinfo/paper31.pdf>. Accessed March 27, 2018.
16. Pickering TG, Hall JE, Appel LJ, et al. Recommendations for blood pressure measurement in humans and experimental animals Part 1: Blood pressure measurement in humans. A statement for professionals from the Subcommittee of Professional and Public Education of the American Heart Association Council on High Blood Pressure Research. *Circulation* 2005 111(5): 697-716.
17. Tolonen H, Wolf H, Jakovljevic D, et al. [Review of surveys for risk factors of major chronic diseases and comparability of the results](#). European Health Risk Monitoring (EHRM) Project. Finnish National Public Health Institute, 2002. Available at: <http://www.thl.fi/publications/ehrm/product1/title.htm>. Accessed April 20, 2018.
18. Handler J, Zhao Y, Egan BM. Impact of the number of blood pressure measurements on blood pressure classification in US adults: NHANES 1999-2008. *The Journal of Clinical Hypertension* 2012; 14(11): 751-759.
19. Mills KT, Bundy JD, Kelly TN, et al. Global disparities of hypertension prevalence and control: a systematic analysis of population-based studies from 90 countries. *Circulation* 2016; 134(6): 441-450.
20. Fryar CD, Ostchega Y, Hales CM, et al. Hypertension prevalence and control among adults: United States, 2015-2016. NCHS data brief, no 289. Hyattsville, MD: National Center for Health Statistics. 2017.
21. Yano Y, Rakugi H, Bakris GL, et al. On-treatment blood pressure and cardiovascular outcomes in older adults with isolated systolic hypertension. *Hypertension* 2017; 69(2): 220-227.
22. American Heart Association. [Understanding blood pressure readings](#). Available at: [http://www.heart.org/HEARTORG/Conditions/HighBloodPressure/KnowYourNumbers/Understanding-Blood-Pressure-Readings\\_UCM\\_301764\\_Article.jsp#.WtpNGlaWzx8](http://www.heart.org/HEARTORG/Conditions/HighBloodPressure/KnowYourNumbers/Understanding-Blood-Pressure-Readings_UCM_301764_Article.jsp#.WtpNGlaWzx8). Accessed April 20, 2018.
23. Maas AHEM, Franke HR. Women's health in menopause with a focus on hypertension. *Netherlands Heart Journal* 2009; 17(2): 68-72.
24. Paulose-Ram R, Gu Q, Kit BK. Characteristics of U.S. adults with hypertension who are unaware of their hypertension, 2011-2014. NCHS data brief, no 278. Hyattsville, MD: National Center for Health Statistics. 2017.
25. Moon JY, Park KJ, Hwangbo Y, et al. A trend analysis of the prevalence, awareness, treatment, and control of hypertension by age group. *Journal of Preventative Medicine and Public Health* 2013; 46(6): 353-359.
26. Abu-Saad K, Chetrit A, Eilat-Ader S, et al. Blood pressure level and hypertension awareness and control differ by marital status, sex, and ethnicity: A population-based study. *American Journal of Hypertension* 2014; 27(12): 1511-1520.
27. Gee ME, Bienek A, McAlister FA, et al. Factors associated with lack of awareness and uncontrolled high blood pressure among Canadian adults with hypertension. *Canadian Journal of Cardiology* 2012; 28(3): 375-382.
28. Thompson AE, Anisimowicz Y, Miedema B, et al. The influence of gender and other patient characteristics on health care-seeking behaviour: a QUALICOPC study. *BMC Family Practice*. 2016; S17: 38. Available at: <https://doi.org/10.1186/s12875-016-0440-0>. Accessed April 20, 2018.
29. Beer-Borst S, Luta X, Hayoz S, et al. Study design and baseline characteristics of a combined educational and environmental intervention trial to lower sodium intake in Swiss employees. *BMC Public Health*. 2018; 18(1): 421.