Fitness of Canadian adults: Results from the 2007-2009 Canadian Health Measures Survey

by Margot Shields, Mark S. Tremblay, Manon Laviolette, Cora L. Craig, Ian Janssen and Sarah Connor Gorber

Abstract

Background
Estimates of obesity, based on body mass index (BMI) reveal that Canadian adults have become heavier over the past quarter century. However, a comprehensive assessment of fitness requires additional measures. This article provides up-to-date estimates of fitness levels of Canadians aged 20 to 69 years. Results are compared with estimates from 1981.

Data and methods
Data are from the 2007-2009 Canadian Health Measures Survey (CHMS). Historical estimates are from the 1981 Canada Fitness Survey. Means, medians and cross-tabulations were used to compare fitness levels by sex and age group and between survey years.

Results
Mean scores for aerobic fitness, flexibility, muscular endurance and muscular strength declined at older ages, and BMI, waist circumference, skinfold measurements and waist-to-hip ratio increased. Males had higher scores than females for aerobic fitness, muscular endurance and muscular strength; females had higher scores for flexibility. Muscular strength and flexibility decreased between 1981 and 2007-2009; BMI, waist circumference and skinfold measurements increased.

Interpretation
Based on results of the fitness tests and anthropometric measurements, many Canadian adults face health risks due to suboptimal fitness levels.

Keywords
anthropometry, body composition, cardiorespiratory fitness, flexibility, muscular endurance, musculoskeletal fitness, obesity, physical fitness, strength

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The health benefits of being physically fit are widely acknowledged. Physical fitness comprises several components including morphological fitness (for example, body mass index, waist circumference, percent body fat, body fat distribution), muscular fitness (for example, strength, muscular endurance, flexibility), motor fitness (for example, speed, agility), cardiorespiratory fitness (for example, aerobic fitness, resting blood pressure, resting heart rate), and metabolic fitness (for example, blood lipid profile, glucose tolerance, insulin sensitivity).[1] The new Canadian Health Measures Survey was designed to collect data about most of these elements of fitness from a representative sample of Canadians aged 6 to 79 years.

In Canada, for the past two decades, we have relied almost exclusively on body mass index (BMI) to assess the fitness of the nation because it can easily be calculated from height and weight. Estimates based on BMI reveal that Canadian adults have become far heavier for their height over the past 25 to 30 years,[2] mirroring a phenomenon observed in both developed and developing countries.[3] BMI is correlated with heath risk, with most studies reporting a J-shaped relationship reflective of an increased risk among underweight, overweight and obese individuals.[4-8] Some recent studies, however, have found that being overweight (but not obese) may be protective against certain causes of mortality.[9,10]

BMI, however, is only one indicator of one component of physical fitness and is, therefore, limited as an assessment of overall fitness. For example, it provides no information on the distribution of body fat. This is an important shortcoming, because excess abdominal fat, as determined by waist circumference, is associated with an increased risk of disease for both sexes and premature mortality for males, independent of BMI.[7,11-16] Furthermore, skinfold thickness is positively associated with increased risk of premature mortality,[16] and is a better predictor of total body fat than BMI.[7]

Other aspects of fitness are also important for health, regardless of BMI or other morphological measures. Cardiorespiratory (aerobic) fitness is protective against cardiovascular disease, diabetes, functional limitations and mortality, independent of BMI and physical activity levels.[17-24] Considerable evidence indicates that musculoskeletal fitness confers substantial health benefits, particularly among women and older people, including decreased risk of mortality, increased mobility, less functional impairment, greater independence, reduced likelihood of falls, lower levels of pain, and an overall increase in quality of life.[25-29] Back health is a leading predictor of low back pain and injury that, in turn, cause decreased productivity and lost time in the workplace, as well as increased use of health care services.[30] A variety of measures, therefore, is required to gain a more complete understanding of the fitness levels of Canadians and associations between fitness and current and future disease risk.

In 2007, in partnership with Health Canada and the Public Health Agency of Canada, Statistics Canada launched the Canadian Health Measures Survey (CHMS).[31,32] In addition to a household interview, the CHMS involved a visit to a mobile examination centre where respondents underwent anthropometric measurements and participated in fitness tests. This survey is the first time in more than two decades that a comprehensive assessment of the fitness of Canadians has been performed. Using data from these assessments, this article provides an up-to-date overview of the fitness levels of Canadians aged 20 to 69 years, including estimates of:

- cardiorespiratory (aerobic) fitness,
- musculoskeletal fitness (including strength, endurance and flexibility),
- body composition (including BMI, waist circumference, waist-to-hip ratio and skinfolds).

Percentage distributions of the health benefits ratings based on fitness scores[33] are also presented. Estimates are provided by sex and age group. Where possible, CHMS results are compared with findings from the 1981 Canada Fitness Survey.

Methods

Data sources

The data are from the Canadian Health Measures Survey, the most comprehensive direct health measures survey ever conducted in Canada on a nationally representative sample.[32,34-36] The CHMS covers the population aged 6 to 79 years living in private households at the time of the interview. Residents of Indian Reserves or Crown lands, institutions and certain remote regions, and full-time members of the Canadian Forces are excluded. The survey was designed to provide statistically reliable national estimates by sex for five age groups: 6 to 11, 12 to 19, 20 to 39, 40 to 59, and 60 to 79 years. Approximately 97% of Canadians are represented.

Ethics approval for conducting the survey was obtained from Health Canada's Research Ethics Board.[35] Written informed consent was obtained from participating respondents. Participation was voluntary; respondents could opt out of any part of the survey at any time.

Data were collected at 15 sites across Canada from March, 2007 through February, 2009. Of the households selected, the response rate was 69.6%—meaning that in 69.6% of the selected households, the sex and date of birth of all household members were provided by a household resident. One or two members of each responding household were chosen to participate in the survey: 87.6% of selected 20- to 69-year-olds completed the household questionnaire, and 83.6% of those who completed the questionnaire participated in the subsequent examination component of the survey. The final response rate for 20- to 69-year-olds, after adjusting for the sampling strategy,[37] was 51.0% (69.6% x 87.6% x 83.6%). This article is based on 3,102 examination participants aged 20 to 69 years. Respondents aged 70 to 79 years were not included in this analysis because only a limited subset of fitness measures was collected for this age group.

Historical estimates of fitness are based on data from the 1981 Canada Fitness Survey (CFS), a nationally representative sample of the Canadian population.[38-40] The survey was initiated and funded by Fitness Canada; the sample was designed by Statistics Canada using the Labour Force Survey sampling frame. The sample consisted of 13,500 households, 88% of which agreed to participate—meaning that basic demographic information was collected for all household members, and a household member agreed to a follow-up visit when all members would be at home. In the responding households, 30,652 people aged 7 years or older were eligible to participate.

The CFS had two components: a questionnaire on health and lifestyle (administered to household members aged 10 years or older) and a physical measures component (for respondents aged 7 to 69 years). A respondent was defined as a household member who completed the questionnaire and/or participated in the physical measures component. In total, 23,400 household members (76%) responded, for an overall response rate of 67% (88% x 76%). Among respondents eligible for the physical measures component, 73% participated, yielding response rate of 49% to this component (88% x 76% x 73%). The CFS estimates in this article are based on 10,911 respondents aged 20 to 69 years. Fitness testing and anthropometric measures were taken in sampled households from February through July 1981, with standardized equipment using standardized procedures. All testing was performed by university graduates with degrees in physical education and recreation and additional qualifications in fitness appraisal.

Measures

As well as a comprehensive health interview conducted in the home, CHMS respondents underwent body composition measurements and participated in fitness tests in a mobile examination centre.[34]

Most of the measurement protocols for assessing body composition, aerobic fitness and musculoskeletal fitness were taken from the Canadian Physical Activity, Fitness and Lifestyle Approach (CPAFLA).[33] A detailed description of the specific collection procedures can be found in the *Canadian Health Measures Survey (CHMS) Data User Guide.*[37]

The CHMS fitness tests and measures were conducted by specialists who had a degree in kinesiology with certification from the Canadian Society for Exercise Physiology (www.csep.ca) as either Certified Exercise Physiologists or Certified Personal Trainers.

Before undergoing any fitness tests, respondents were interviewed to ensure that they were physically capable of performing the tests for which they were eligible. They were asked about their physical and health conditions and their use of prescription medications, and a Physical Activity Readiness Questionnaire (PAR-Q) was completed and signed (http://www.csep.ca/CMFiles/publications/parq/par-q.pdf). To ensure their safety, respondents were screened out of some tests, depending on their answers to the screening questions. Respondents were also asked to adhere to the pre-testing guidelines about food, alcohol, caffeine, nicotine, exercise, and blood donations.

The anthropometric measures collected included height, weight, waist circumference, hip circumference and skinfold measurements. Height was measured using a ProScale M150 digital stadiometer, (Accurate Technology Inc., Fletcher, USA), and weight was taken with a Mettler Toledo VLC with Panther Plus terminal scale (Mettler Toledo Canada, Mississauga, Canada). Waist circumference was measured with a Gulick measuring tape (Fitness Mart, Gay Mills, USA), following the World Health Organization (WHO) protocol[41] (mid-point between last floating rib and top of iliac crest in the mid-axillary line). Hip circumference was measured following the Canadian Standardized Test of Fitness (CSTF) protocol,[42] at the level of the symphysis pubis and the greatest gluteal protuberance. Skinfolds were measured using Harpenden skinfold calipers (Baty International, UK) at five sites: triceps, biceps, subscapular, iliac crest and calf[33] for respondents with a BMI less than 30kg/m^2. BMI, waist-to-hip ratio, and the sum of five skinfolds were calculated according to standard procedures.[33,42]

Health benefit ratings were derived from the anthropometric measurements. Based on BMI, respondents were classified as underweight (less than 18.5 kg/m^2), normal weight (18.5 to 24.9 kg/m^2), overweight (25 to 29.9 kg/m^2), or obese (30 kg/m^2 or more).[3] Based on waist circumference, respondents' health risk was classified as low (less than 80 cm in females; less than 94 cm in males), increased (80 to 87 cm in females; 94 to 101 cm in males) or high (more than 87 cm in females; more than 101 cm in males).[3,33,43,44] An overall body composition health rating was assessed by using a combination of BMI, waist circumference and the sum of five skinfolds, as defined in the CPAFLA.[33]

Aerobic fitness was measured using the modified Canadian Aerobic Fitness Test (mCAFT). Respondents were required to complete one or more three-minute "stepping" stages (up and down steps with increasing intensity as stages increased) at predetermined speeds based on their age and sex.[33] Their heart rate was recorded after each stage. The test was completed once a respondent's heart rate reached 85% of their age-predicted maximal heart rate (220–age). The predicted maximal aerobic power (VO_2 max) was calculated based on the last completed stage.[33,45,46] (In the CPAFLA, the term "aerobic fitness score" is used, which is derived from the predicted VO_2 max.) Respondents who completed at least one stage, but stopped midway through a subsequent stage (referred to as "partials"), were assigned a score based on the last fully completed stage. Typically, "partials" were due to respondents being unable to maintain the cadence of the stepping test. Those who were unable to complete a single stage were coded as "not stated" and were not assigned an aerobic fitness score.

Muscular strength was assessed by measuring grip strength twice on each hand (alternating) using a Smedley III hand-grip dynamometer (Takei Scientific Instruments, Japan) and combining the maximum score for each hand (in kg). Muscular endurance was measured with the partial curl-ups test, which required respondents to perform as many partial curl-ups as possible in one minute, at a set pace, to a maximum of 25. Flexibility was assessed using the sit-and-reach test, for which respondents sat on a mat on the floor with their legs extended against a flexometer (a device that measures the distance of a stretch) (Fit Systems Inc., Calgary, Canada), and the best of two attempts to stretch forward as far as possible without bending the knees was recorded to the nearest 0.1 cm.

According to definitions specified in the CPAFLA,[33] respondents were assigned "health benefit ratings" of excellent, very good, good, fair or needs improvement, based on their score for each fitness test (aerobic fitness, flexibility, muscular endurance and muscular strength) and their sex and age. An overall musculoskeletal fitness health benefit rating was assessed based on the results of the grip strength, partial curl-ups and sit-and-reach tests; a back fitness health benefit rating was also calculated based on the results of the waist circumference, partial curl-ups and sit-and-reach tests.[33]

The 1981 Canada Fitness Survey[39] assessed grip strength, sit-and-reach and anthropometric measurements following collection protocols similar to those used for the CHMS.

Analytical techniques

Data were analysed separately by sex for three age groups: 20 to 39, 40 to 59, and 60 to 69 years. Estimates of means, standard deviations and medians were produced for all fitness measures (body composition measurements and fitness test scores). Estimates of the means and medians for most measures were similar, but in some cases, means were marginally higher, reflecting distributions that were somewhat positively skewed. An exception was the distribution of the number of partial curl-ups completed in one minute (to a maximum of 25). In this case, the distribution of scores was bimodal, with large percentages of respondents completing either 0 or 25 partial curl-ups. As a result, for this measure, percentage distributions are presented.

Comparisons with the 1981 CFS were made for grip strength, sit-and-reach flexibility, and all body composition measurements. Comparisons of muscular endurance could not be made between the CHMS and the CFS, because the partial curl-up test, which was used to assess this component of fitness in the CHMS, was administered as speed sit-ups in the CFS. Although the same testing modality was used to assess aerobic fitness in the two surveys, small differences in the protocols between the two surveys negate a direct temporal comparison. A full understanding of the impact of these differences requires additional analyses that are beyond the scope of this study, but which will be conducted in future research.

Percentage distributions of the health benefits ratings are presented. Ratings for aerobic and musculoskeletal fitness are based on age-specific cut-points defined in the CPAFLA[33] that account for changes in fitness that are expected to occur with age. For adults, the CPAFLA cut-points apply to 10-year age groupings (20 to 29, 30 to 39, 40 to 49, 50 to 59, and 60 to 69). CHMS respondents were assigned health benefit ratings specific to these 10-year age groupings; estimates were then aggregated to the three broader age groups (20 to 39, 40 to 59, and 60 to 69) considered in this paper. The same age-specific cut-points were applied to CFS data for historical comparisons.

As in the CHMS, CFS respondents were interviewed before undergoing any fitness tests to ensure they were physically able to perform the tests. The CFS used the same screen-out procedures for all fitness tests, which was similar to the procedures used for the mCAFT for the CHMS. Thus, for comparisons of grip strength and sit-and-reach between the two surveys, respondents who were screened out of the mCAFT were also excluded from CHMS estimates for grip strength and sit-and-reach.

Because of the potential for changes over time in the age distribution within the three age groups considered in this paper, historical age-adjusted estimates were calculated standardizing to the CHMS population (using 5-year age groupings). In all cases, the crude and age-standardized estimates for means were similar; therefore, only crude estimates are presented.

Fitness profiles of a typical 45-year-old man and woman in 1981 and in 2007-2009 are compared. Because 45 is the midpoint of the 20-to-69-year age range examined in this paper, it was chosen as the age of comparison. To ensure adequate sample sizes, estimates are based on median values for adults aged 43 to 47 years. The silhouettes used to present the comparisons are for illustration only, and are not sized to scale.

To account for the survey design effects of the CHMS, standard errors, coefficients of variation, and 95% confidence intervals were estimated using the bootstrap technique.[47,48] Estimates of sampling error for the CFS are based on formulae for simple random sampling with the incorporation of a design effect of 1.5 to account for the complex design of the CFS. Differences between estimates were tested for statistical significance, established at the level of $p < 0.05$.

Response, non-response and screen-out rates for all of the CHMS fitness tests are given in Appendix Table A. Among respondents who participated in the examination component, partial non-response (opting out of certain tests or portions of tests) to the fitness tests and anthropometric measures was rare. Appendix Table B compares screen-out rates for the mCAFT for the CHMS with screen-out rates for the CFS fitness test.

Results

Response outcomes

Virtually all adults who participated in the examination component of the CHMS completed the flexibility (sit-and-reach) and muscular strength (grip strength) tests, and were assigned scores (Appendix Table A). Some were screened out of the aerobic fitness test (mCAFT) and the muscular endurance test (partial curl-ups)—most because of health problems they reported during the screening procedures. Somewhat more than half (57% of males; 56% of females) of those aged 60 to 69 years were screened out of the mCAFT; just over one-quarter of males and females aged 40 to 59 years were screened out, as were 9% of males and 15% of females aged 20 to 39 years. The percentages of males screened out of the partial curl-up test ranged from 10% at ages 20 to 39 years to 17% at ages 60 to 69 years, and among females, from 10% to 24%, respectively.

Sample sizes for all CHMS fitness measures are given in Appendix Table C. Body composition measurements were taken for virtually all examination participants.

Fitness measures

Mean aerobic fitness levels, measured by predicted maximal aerobic power ($ml \cdot (kg \cdot min)^{-1}$), were highest at ages 20 to 39 years and decreased with advancing age (Table 1). Males aged 20 to 39 years had a mean aerobic fitness score of 44 $ml \cdot (kg \cdot min)^{-1}$; for those aged 60 to 69 years, the mean was 28 $ml \cdot (kg \cdot min)^{-1}$. Declines were similar among females: from 38 $ml \cdot (kg \cdot min)^{-1}$ to 24 $ml \cdot (kg \cdot min)^{-1}$, respectively. In each age group, males had higher mean scores than did females.

An age gradient was apparent for each of the three measures of musculoskeletal fitness, with younger adults having better flexibility, endurance and strength than older Canadians. At all ages, females demonstrated greater flexibility than did males. However, over one-third of females aged 20 to 39 years and the majority of those aged 40 years or older were unable to complete even one partial curl-up. Fewer than a third (31%) of females aged 20 to 39 years completed the full 25 curl-ups, and at ages 60 to 69 years, the percentage was 4%. Higher percentages of males completed the full 25 curl-ups: 55% of 20- to 39-year-olds and 12% of 60- to 69-year-olds. In each age group, males had greater grip strength than did females, and strength declined with advancing age in both sexes.

Mean BMI rose with age. Moreover, in all age groups and among both sexes, mean BMI was above 25 kg/m^2, the WHO overweight cut-point.[3] Waist circumference and waist-to-hip ratios also increased with age, and were higher in males than females. By contrast, skinfold measurements were higher in females than in males and increased with age among females. Among males, mean skinfold measurements were similar in the youngest and oldest age groups and were higher at ages 40 to 59 years.

Health benefit ratings

Health benefit rating results for each fitness measure are presented in Table 2. The "excellent" and "very good" categories and the "fair" and "needs improvement" categories were combined to ensure sufficient sample size for all measures. Health benefit ratings for aerobic and musculoskeletal fitness are based on age-specific cut-points that account for changes expected to occur with advancing age.

At ages 20 to 39 years, 27% of males and 23% of females were assigned excellent/very good *aerobic fitness* ratings; at ages 60 to 69 years, 10% of males and fewer than 5% of females received excellent/very good aerobic fitness ratings.

Table 1
Descriptive statistics for selected fitness measures, by sex and age group, household population aged 20 to 69 years, Canada, March 2007 to February 2009

	20 to 39 years			40 to 59 years			60 to 69 years		
		95% confidence interval			95% confidence interval			95% confidence interval	
Fitness measure and sex	Estimate	from	to	Estimate	from	to	Estimate	from	to
Aerobic fitness: predicted maximal aerobic power (ml • (kg • min)$^{-1}$)									
Mean									
Male	44.1	43.1	45.1	36.6†	35.5	37.6	27.6†	26.6	28.5
Female	38.4*	37.6	39.3	31.2†*	30.5	31.8	24.1†*	23.6	24.6
Standard deviation									
Male	6.6	...	...	6.1	...	...	5.0	...	...
Female	4.8	...	...	5.3	...	...	3.7	...	...
50th percentile									
Male	44.0	42.7	45.3	38.2†	36.4	40.0	27.6†	26.6	28.6
Female	38.1*	37.1	39.1	31.0†*	30.3	31.7	23.1†*	22.6	23.6
Flexibility: sit-and-reach (cm)									
Mean									
Male	25	24	27	25	24	26	17†	16	19
Female	31*	30	31	29†*	27	30	27†*	26	28
Standard deviation									
Male	10	...	...	10	...	...	10	...	...
Female	9	...	...	10	...	...	9	...	...
50th percentile									
Male	25	24	27	25	24	26	18†	16	20
Female	31*	30	31	30*	28	31	28†*	25	30
Muscular endurance: number of partial curl-ups in one minute (maximum 25)									
% completing zero									
Male	10[E]	6	14	29†	24	34	69†	60	77
Female	37*	31	42	59†*	51	67	85†*	77	92
% completing 1 to 24									
Male	34	28	41	35	30	40	20†	14	25
Female	33	27	38	28	20	35	12†*[E]	5	18
% completing 25									
Male	55	49	62	36†	33	39	12†[E]	8	16
Female	31*	26	35	13†*	10	17	4†*[E]	2	6
Muscular strength: grip strength (kg)									
Mean									
Male	97	94	99	93†	91	95	81†	79	83
Female	56*	54	58	54†*	53	55	48†*	47	49
Standard deviation									
Male	16	...	...	15	...	...	15	...	...
Female	11	...	...	10	...	...	9	...	...
50th percentile									
Male	98	95	101	92†	90	94	82†	81	83
Female	56*	54	58	54†*	53	55	47†*	46	48
Body mass index (kg/m^2)									
Mean									
Male	26.5	26.3	26.8	28.3†	27.7	29.0	28.5†	28.0	29.0
Female	25.9	24.9	26.8	27.0†*	26.3	27.7	28.7†	27.9	29.4
Standard deviation									
Male	5.0	...	...	4.6	...	...	5.0	...	...
Female	6.3	...	...	5.9	...	...	6.1	...	...
50th percentile									
Male	25.7	25.4	26.1	27.9†	27.2	28.6	28.0†	27.2	28.8
Female	24.3*	23.2	25.3	25.6†*	25.0	26.2	27.4†	26.4	28.3
Waist circumference (cm)									
Mean									
Male	91	90	92	99†	97	101	103†	101	104
Female	83*	81	85	88†*	86	90	94†*	91	96
Standard deviation									
Male	14	...	...	13	...	...	13	...	...
Female	15	...	...	15	...	...	15	...	...
50th percentile									
Male	89	87	91	98†	96	99	102†	99	105
Female	79*	76	82	86†*	83	88	93†*	90	95
Sum of five skinfolds (mm)‡									
Mean									
Male	61	59	64	67†	62	71	62	59	65
Female	82*	78	86	90†*	86	94	94†*	91	98
Standard deviation									
Male	24	...	...	23	...	...	21	...	...
Female	30	...	...	30	...	...	26	...	...
50th percentile									
Male	58	52	64	63	58	69	59	54	63
Female	77*	70	84	89†*	83	94	92†*	86	98
Waist-to-hip ratio									
Mean									
Male	0.88	0.88	0.89	0.95†	0.94	0.96	0.99†	0.98	1.00
Female	0.80*	0.79	0.81	0.84†*	0.83	0.85	0.87†*	0.86	0.88
Standard deviation									
Male	0.07	...	...	0.07	...	...	0.11	...	...
Female	0.07	...	...	0.07	...	...	0.07	...	...
50th percentile									
Male	0.88	0.87	0.89	0.95†	0.94	0.96	0.99†	0.98	1.00
Female	0.79*	0.77	0.81	0.83†*	0.82	0.84	0.87†*	0.85	0.89

* significantly different from estimate for males ($p < 0.05$)
† significantly different from estimate for 20- to 39-year-olds ($p < 0.05$)
‡ excludes respondents with BMI 30.0 kg/m^2 or higher
E use with caution (coefficient of variation 16.6% to 33.3%)
... not applicable
Source: 2007-2009 Canadian Health Measures Survey.

The most common *flexibility* rating was fair/needs improvement. Over half (55%) of females aged 20 to 39 years and just under half of those in the 40-to 69-year age range were assigned this suboptimal rating. Approximately 60% of younger and older males were in this category, compared with 42% of middle-aged males.

In all three age groups, females were more likely than males to have *muscular endurance* scores that placed them in the fair/needs improvement category. For both sexes, percentages in this suboptimal category rose with age.

The percentage of females rated as having excellent/very good *muscular strength* increased with age, while among males, 40- to 59-year-olds had the highest percentage in this category.

Scores on flexibility, muscular endurance and strength were combined into an overall musculoskeletal heath benefit rating. Approximately half of females aged 20 to 39 years were assigned musculoskeletal health in the fair/needs improvement category. The percentage fell to 43% among females aged 40 to 59 years, and to 38% at ages 60 to 69 years. Among males, just under one-third in the 20-to-59-year age range were in the fair/needs improvement category; the percentage rose to 61% at ages 60 to 69 years.

Based on BMI, 19% of males and 21% of females aged 20 to 39 years were classified as obese; at ages 60 to 69 years, the percentage was approximately one-third. On the basis of their waist circumference, 31% of females and 21% of males aged 20 to 39 years were considered to be at high risk for health problems; by ages 60 to 69 years, the percentages were more than twice as high: 65% of females and 52% of males.

Composite scores were calculated for overall body composition (based on BMI, waist circumference and skinfolds) and for back fitness (based on flexibility, abdominal muscular endurance and waist circumference). For body composition, higher percentages of females than males aged 20 to 39 years were in the fair/needs improvement category, and for both

Table 2
Percentage distribution of health benefit ratings of selected fitness measures, by sex and age group, household population aged 20 to 69 years, Canada, March 2007 to February 2009

	20 to 39 years			40 to 59 years			60 to 69 years		
		95% confidence interval			95% confidence interval			95% confidence interval	
Health benefit rating and sex	%	from	to	%	from	to	%	from	to
Aerobic fitness health benefit zone									
Fair/Needs Improvement									
Male	46	41	51	32†	25	39	59†	51	67
Female	37*	31	44	56†*	50	61	92†*	88	95
Good									
Male	26	20	33	40†	32	47	31	24	38
Female	40*	37	44	20†*	16	24	8†*E	5	12
Excellent/Very good									
Male	27	19	36	28	24	33	10†E	5	15
Female	23	16	29	24*	21	27	<5†*		
Flexibility (sit-and-reach) health benefit zone									
Fair/Needs Improvement									
Male	61	55	66	42†	37	47	57	52	62
Female	55	52	59	47	39	56	46†*	40	53
Good									
Male	16	12	21	19	15	22	19	14	23
Female	16	12	19	20	14	26	18	14	23
Excellent/Very good									
Male	23	19	27	39†	36	43	24	19	29
Female	29*	26	32	33	28	37	36*	29	43
Muscular endurance (partial curl-ups) health benefit zone									
Fair/Needs Improvement									
Male	19	14	23	39†	33	45	75†	69	81
Female	46*	41	52	70†*	64	76	87†*	80	94
Good									
Male	7E	4	9	5E	3	7	3†E	1	5
Female	10	7	13	9*	6	12	<6†		
Excellent/Very good									
Male	75	70	80	56†	49	62	22†	16	28
Female	44*	39	49	21†*	17	25	10†*E	5	15
Muscular strength (grip strength) health benefit zone									
Fair/Needs Improvement									
Male	42	35	49	35†	28	42	58†	52	64
Female	56*	50	61	36†	29	44	37†*	30	44
Good									
Male	24E	15	32	19E	11	27	18	12	23
Female	18	14	22	29†	24	34	13†	9	17
Excellent/Very good									
Male	34	27	42	46†	40	52	24†	17	31
Female	27	19	34	35†*	29	40	50†*	44	56
Overall musculoskeletal health benefit zone‡									
Fair/Needs Improvement									
Male	30	25	36	29	23	35	61†	54	67
Female	51*	46	56	43†*	38	47	38†*	32	44
Good									
Male	32	26	38	30	24	36	25	19	31
Female	28	23	33	36†	32	41	38†*	33	43
Excellent/Very good									
Male	38	31	44	41	36	46	14†	10	19
Female	21*	17	24	21*	17	24	24	17	31
Body mass index category§									
Obese									
Male	19	15	23	27†	21	32	34†	29	39
Female	21	16	25	24	19	29	33†	26	41
Overweight									
Male	37	30	45	52†	47	57	39	36	43
Female	23*	17	30	31*	27	35	37†	32	41
Normal weight									
Male	43	37	48	21†	15	26	26†	19	33
Female	50	41	60	45*	40	49	30†	23	37
Waist circumference health risk									
High risk									
Male	21	18	24	38†	30	45	52†	43	60
Female	31*	25	37	47†	41	53	65†*	56	74
Increased risk									
Male	14	11	18	27†	21	32	23†	18	29
Female	17E	11	23	18*	13	24	17E	11	23
Low risk									
Male	65	61	69	36†	29	42	25†	19	32
Female	52*	43	61	35†	29	41	18†*	13	23
Body composition health benefit zone††									
Fair/Needs Improvement									
Male	20	17	23	33†	27	40	40†	32	47
Female	29*	23	34	36†	31	42	47†	38	55
Good									
Male	<5			7†E	4	9	12†	8	15
Female	<6			10†	7	13	18†*	15	22
Excellent/Very good									
Male	77	73	82	60†	52	67	48†	40	57
Female	68*	61	74	54†	48	59	35†*	26	44
Back fitness health benefit zone‡‡									
Fair/Needs Improvement									
Male	22	18	25	34†	28	40	60†	53	68
Female	30*	24	36	42†	35	49	62†	55	70
Good									
Male	21	15	27	23	18	29	21	15	26
Female	17	12	22	21	17	25	17	13	22
Excellent/Very good									
Male	58	53	62	43†	37	49	19†	14	24
Female	53	47	59	37†	30	43	20†	14	26

* significantly different from estimate for males ($p < 0.05$)
† significantly different from estimate for 20- to 39-year-olds ($p < 0.05$)
‡ based on flexibility, muscular endurance and muscular strength
§ estimates for underweight not reported because of small sample sizes
†† based on BMI, waist circumference and sum of five skinfolds
‡‡ based on flexibility, muscular endurance and waist circumference
E use with caution (coefficient of variation 16.6% to 33.3%)
Note: If coefficient of variation of estimate is greater than 33%, estimate is indicated as being less than upper limit of 95% confidence interval.
Source: 2007-2009 Canadian Health Measures Survey.

sexes, the prevalence of poorer ratings increased with age. The pattern was similar for back fitness.

Historical comparisons

Historical comparisons were made with data collected in the 1981 CFS where comparable tests were administered for flexibility and muscular strength, and similar anthropometric measurements were taken. To make estimates more comparable, respondents screened out of the aerobic fitness test were excluded from CHMS estimates of flexibility and muscular strength (see *Methods*). Screen-out rates (based on the aerobic fitness test) were similar between the two surveys across age groups and for both sexes (Appendix Table B).

Between 1981 and 2007-2009, muscular strength decreased in both males and females aged 20 to 59 years (Table 3). Flexibility declined for both sexes among those aged 20 to 39 years and for males aged 60 to 69 years. Mean values for BMI, waist circumference and skinfold measurements rose for both sexes in all age groups.

The percentage of Canadians with suboptimal ratings for flexibility and muscular strength in the CFS and the CHMS are presented in Figure 1. The percentage in the fair/needs improvement category for muscular strength rose between 1981 and 2007-2009, except among 60- to 69-year-old males, for whom the increase was not significant. The percentage in the fair/needs improvement category for flexibility rose only among males and females aged 20 to 39 years. The percentages who had a waist circumference indicative of high risk, were obese, or had body composition scores in the fair/needs improvement category more than doubled in all groups except females aged 40 to 59 years, among whom obesity almost doubled (Figure 2). At ages 20 to 39 years, the percentage whose waist circumference was classified as high risk more than quadrupled, and the percentage with body composition classified as fair/needs improvement increased fourfold among males, and sevenfold among females.

A typical 45-year-old

The 1981 and 2007-2009 fitness profiles of a typical 45-year-old man and woman are presented in Figure 3 (see *Analytical techniques*). In 2007-2009, the average 45-year-old man was about 9.2 kg (20 pounds) heavier than his 1981 counterpart, though his height was not significantly different. As a result, BMI rose by more than 2 kg/m^2. Waist circumference increased by 6.4 cm (2.5 inches), which meant a change in classification from a low risk of health problems for the average man in 1981 to an increased risk in 2007-2009. The average man's grip strength rating decreased from very good to good, while his sit-and-reach score in 2007-2009 was slightly higher than in 1981. His aerobic fitness was "good" in 2007-2009.

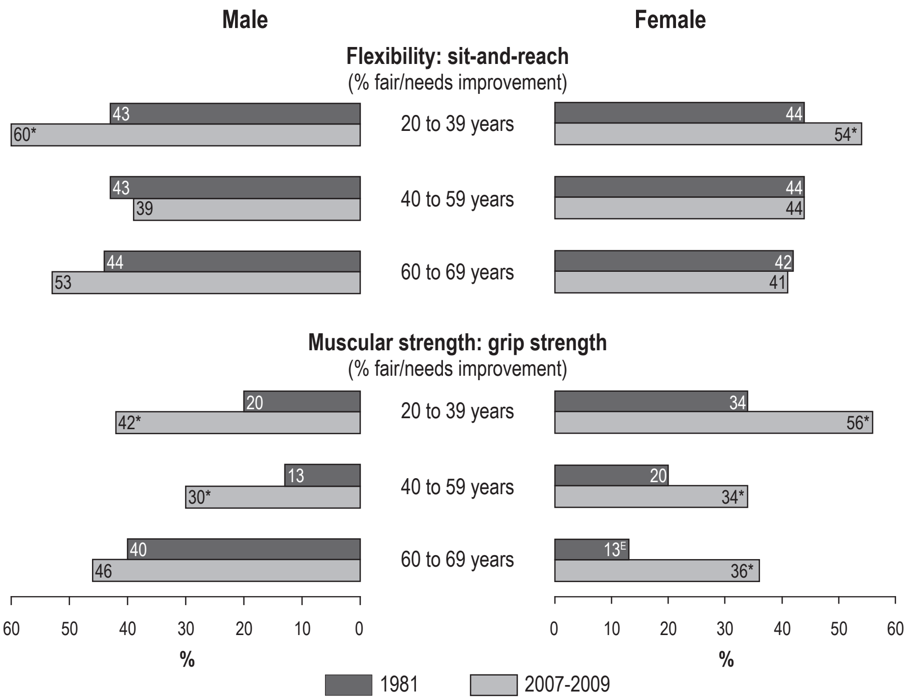
The height of a typical 45-year-old woman stayed relatively constant over the period, but her weight increased by 5.2 kg (12 pounds). Her BMI rose by close to 2 kg/m^2, moving her from the normal weight to the overweight category, and the 7.1 cm (2.8 inches) increase in her waist circumference moved her from

Table 3
Mean and median values for selected fitness measures, by sex and age group, household population aged 20 to 69 years, Canada, 1981 and 2007-2009

Fitness measure, sex and survey year	20 to 39 years		40 to 59 years		60 to 69 years	
	Mean	Median	Mean	Median	Mean	Median
Flexibility: sit-and-reach (cm)						
Male						
1981	30	30	25	25	22	23
2007-2009	25*	26*	26	26	18*	19
Female						
1981	32	33	30	31	28	28
2007-2009	31*	31*	30	30	28	29
Muscular strength: grip strength (kg)						
Male						
1981	107	107	100	100	87	87
2007-2009	97*	98*	93*	93*	84	84
Female						
1981	62	61	59	58	52	51
2007-2009	56*	56*	55*	55*	49	48
Body mass index (kg/m^2)						
Male						
1981	24.4	24.0	26.1	25.8	26.6	26.3
2007-2009	26.5*	25.7*	28.3*	27.9*	28.5*	28.0*
Female						
1981	22.5	21.8	25.0	24.3	25.8	25.4
2007-2009	25.9*	24.3*	27.0*	25.6*	28.7*	27.4*
Waist circumference (cm)						
Male						
1981	85	84	92	92	95	95
2007-2009	91*	89*	99*	98*	103*	102*
Female						
1981	72	70	78	76	82	80
2007-2009	83*	79*	88*	86*	94*	93*
Sum of five skinfolds (mm)†						
Male						
1981	51	48	56	56	56	55
2007-2009	61*	58*	67*	63*	62*	59
Female						
1981	66	63	78	77	80	80
2007-2009	82*	77*	90*	89*	94*	92*

* significantly different from estimate for 1981 ($p < 0.05$)
† excludes respondents with BMI 30.0 kg/m^2 or higher
Note: To make estimates more comparable, Canadian Health Measures Survey estimates for flexibility and muscular strength exclude respondents screened out of aerobic fitness test (see *Methods*).
Source: 1981 Canda Fitness Survey; 2007-2009 Canadian Health Measures Survey.

Figure 1
Percentage with suboptimal health benefit ratings for selected fitness measures, by sex and age group, household population aged 20 to 69 years, Canada, 1981 and 2007-2009



* significantly higher than estimate for 1981 (p<0.05)
E use with caution (coefficient of variation 16.6% to 33.3%)
Note: To make estimates more comparable, Canadian Health Measures Survey estimates for flexibility and muscular strength exclude respondents screened out of aerobic fitness test (see *Methods*).
Sources: 1981 Canada Fitness Survey; 2007-2009 Canadian Health Measures Survey.

a low to an increased risk of health problems. Her grip strength decreased, and her flexibility was approximately the same. In 2007-2009, her aerobic fitness was rated "good."

Discussion

The purpose of this article was to provide an overview of the current fitness of Canadians aged 20 to 69 years, including estimates of cardiorespiratory (aerobic) fitness, musculoskeletal fitness, and body composition. Where possible, results from the 2007-2009 CHMS were compared with findings from the 1981 CFS to illustrate temporal trends in fitness. A main observation of this study was that, independent of age and sex, a large percentage of adults in the CHMS had suboptimal health benefit ratings for all the fitness components. Most fitness scores declined across the three age groups considered. Several sex differences in fitness were noted, which likely reflect fundamental anatomical, physiological and behavioural differences between the sexes.[49] Based on comparable fitness measures in the 1981 and 2007-2009 surveys, in most instances, results were more favourable in the earlier survey, implying that the fitness of the nation has declined over the past two decades.

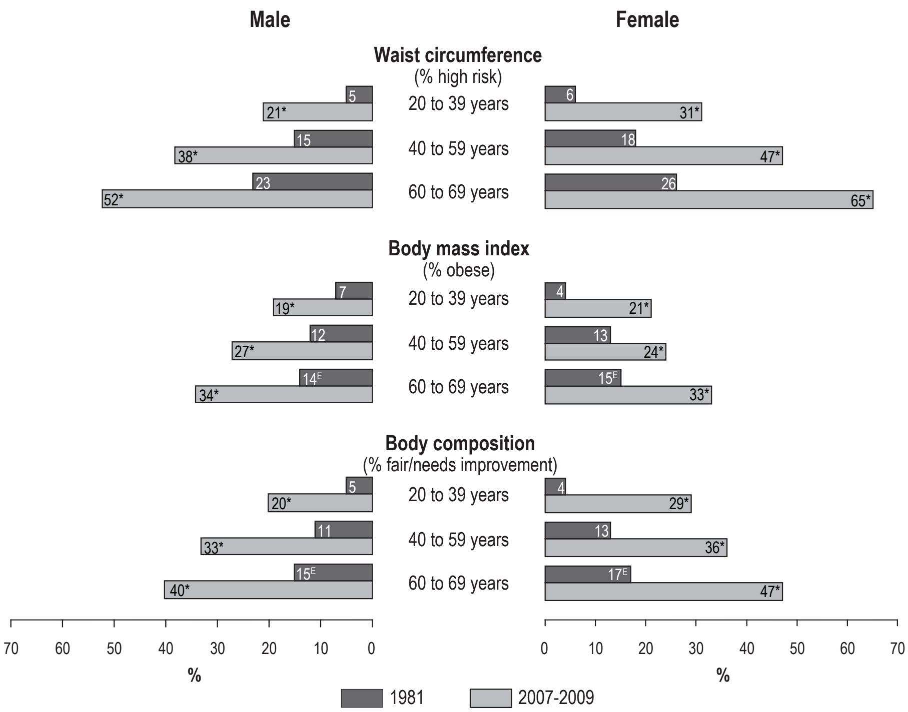
In the CHMS, middle-aged males had higher BMI values than did females, and males had higher waist-to-hip ratios than did females, independent of age. BMI and waist-to-hip ratio values were higher in older age groups, independent of sex. The patterns are consistent with those of earlier studies in Canada[50] and elsewhere.[51-53] Similarly, the higher adiposity levels based on the sum of skinfolds among females compared with males and the increase with advancing age among females are as expected, given earlier results.[50,52]

The high prevalence of overweight and obesity in the CHMS is consistent with recent data, based on measured heights and weights from the 2004 Canadian Community Health Survey.[2] Even more important than the high prevalence of overweight and obesity was the prevalence of increased health risk and high health risk, based on waist circumference. The abdominal obesity phenotype, as reflected by a high waist circumference, is now regarded as the obesity phenotype that indicates the greatest obesity-related health risk.[7,11-15] Of particular note, at ages 60 to 69, 75% of males and 82% of females had waist circumference values in the increased-to-high risk range.

The waist circumference values of Canadian males and females appear to be lower than those of Americans. The typical 45-year-old Canadian man had a waist circumference of 97.0 cm; the mean waist circumference of 40- to 49-year-old American men in 2003-2004 was 101.9 cm.[54] The corresponding values for Canadian and American women were 83.4 cm and 95.2 cm,[54] respectively. Although the waist circumference measurement sites in the CHMS (mid-point between last rib and iliac crest) and the United States (iliac crest) differed, the small disparities in waist circumference values between these two sites (0.3 cm and 1.9 cm higher at iliac crest in males and females, respectively[55]) cannot account for most of the observed differences between the Canadian and American populations.

Approximately one quarter of 20- to 39-year-olds in the CHMS had aerobic fitness values in the very good/excellent range; by ages 60 to 69 years, only 10% of males and fewer than 5% of females remained in this category. The age-related decline in aerobic fitness is a well-known phenomenon,[50-53] explained, in part, by less participation in physical activity by older adults.[56] Age-related physiological adaptations,

Figure 2
Percentage with suboptimal health benefit ratings for selected anthropometric measures, by sex and age group, household population aged 20 to 69 years, Canada, 1981 and 2007-2009



* significantly higher than estimate for 1981 (p<0.05)
E use with caution (coefficient of variation 16.6% to 33.3%)
Sources: 1981 Canada Fitness Survey; 2007-2009 Canadian Health Measures Survey.

such as a decrease in maximal heart rate and muscle mass, also likely contribute to the age difference in aerobic fitness.[57] Nationally representative data on aerobic fitness have been obtained in other countries, such as the United States,[53] but differences in study protocols (for example, exclusion criteria, fitness test employed, low fitness cut-points) make it difficult to compare CHMS results with these other countries.

For each of the three age groups examined, mean flexibility (sit-and-reach) values were higher among females, while muscular strength (grip strength) and muscular endurance (partial curl-ups) scores were better in males. This pattern is consistent with earlier studies in Canada[50] and elsewhere.[51-53]

The CHMS data on musculoskeletal fitness, at least for grip strength, appear to be comparable to those obtained in other countries. For instance, in a nationally representative cohort of 53-year-old British adults, mean grip strength values (strongest hand only) were 48 kg in males and 27 kg in females.[58] For 53-year-old CHMS participants, the mean grip strength values for the strongest hand were 47 kg in males and 26 kg in females.

All four measures of adiposity and fat distribution increased considerably since 1981. Average BMI rose by approximately 2 units for males across all age groups. The increase was similar for middle-aged females, but a larger increase of 3 units was observed for younger and older females. Males' average waist circumference increased by 5 cm or more, and females', by 10 cm or more. The apparent sex difference in changes in waist circumference among Canadian adults does not mirror trends in the United States, where changes in waist circumference since the late 1980s were similar in males and females (4.4 versus 5.0 cm).[54]

Currently, the average 20- to 39-year-old man and woman are overweight and have the same body composition profile as those who were aged 40 years or older in 1981. If these trends continue for another 25 years, half of males and females over the age of 40 years will be obese (BMI 30 kg/m^2 or more), with commensurate increases in the personal and economic burden of avoidable non-communicable disease.

Differences in the aerobic fitness test protocols used in the CFS and CHMS make direct comparisons difficult, and for this reason, results were not compared in this study. This was not the case for the flexibility and muscular strength tests. Flexibility (sit-and-reach) among males and females aged 20 to 39 years and muscular strength (grip strength) for males and females in the 20-to-59-year age range decreased. In 1981, the typical 45-year-old man and woman had grip strength values of 104 kg and 62 kg, respectively. These values are 10 kg and 6 kg (around 10%) lower in the typical 45-year-old of today. Temporal changes in grip strength of this magnitude at the population level are meaningful. To put this into context, the results of a 25-year prospective cohort study of grip strength and physical disability risk (such as slow walking speed, unable to stand from chair) in middle-aged males[27] found that between-group differences in grip strength that were comparable to the temporal changes between the CFS and the CHMS were associated with about a twofold increased risk of developing physical disability over the follow-up period.

Limitations

The two most important limitations of this study were the screening criteria used for the various CHMS fitness tests and the non-response rate.

The exclusions imposed to ensure respondent safety could have biased the sample. In particular, because of the screening questions on health conditions, unfit individuals would be more likely to have been screened out. Consequently, the fitness data may be more favourable

Figure 3
Portrait of typical 45-year-old male and female, 1981 and 2007-2009

MALE

1981	BODY COMPOSITION	2007-2009
173.0 cm (5'8")	Height	175.3 cm (5'9")
77.4 kg (171 pounds)	Weight	86.6 kg (191 pounds)*
25.7 kg/m² - overweight	Body mass index	27.9 kg/m²* - overweight
90.6 cm (35.7") - low risk	Waist circumference	97.0 cm (38.2")* - increased risk
99.0 cm (39.0")	Hip circumference	102.7 cm (40.4")*
0.91	Waist-to-hip ratio	0.95*
	FITNESS TESTS	
104 kg - very good	Grip strength	94 kg* - good
23.1 cm - fair	Sit-and-reach	26.7 cm* - good
--	Predicted maximal aerobic power (VO_2max)	39.2 ml•(kg•min)$^{-1}$ - good

FEMALE

1981	BODY COMPOSITION	2007-2009
161.5 cm (5'4")	Height	162.3 cm (5'4")
63.2 kg (139 pounds)	Weight	68.4 kg (151 pounds)*
24.1 kg/m² - normal weight	Body mass index	25.8 kg/m²* - overweight
76.3 cm (30.0") - low risk	Waist circumference	83.4 cm (32.8")* - increased risk
98.5 cm (38.8")	Hip circumference	102.5 cm (40.4")*
0.77	Waist-to-hip ratio	0.81*
	FITNESS TESTS	
62 kg - very good	Grip strength	56 kg* - good
30.2 cm - good	Sit-and-reach	31.5 cm - good
--	Predicted maximal aerobic power (VO_2max)	32.8 ml•(kg•min)$^{-1}$ - good

* significantly different from estimate for 1981 ($p<0.05$)
Note: To make estimates more comparable, Canadian Health Measures Survey estimates for flexibility and muscular strength exclude respondents screened out of aerobic fitness test (see *Methods*).
Sources: 1981 Canada Fitness Survey; 2007-2009 Canadian Health Measures Survey.

than if 100% of the eligible sample could have participated in the testing. For instance, while the mean BMI of the adults who completed the aerobic fitness test was 26.5 kg/m², the mean BMI of the 25% who were screened out of the test was 29.2 kg/m², indicating a lower level of morphological fitness. The CHMS directly measured physical activity levels with accelerometers that were provided to *all* ambulatory respondents. These data will be released later this year and will make it possible to further examine the bias associated with the screening procedures for the fitness tests.

The overall non-response rate was 49%. Although the sampling weights were adjusted to compensate for all three levels of non-response, fitness estimates could be biased if less fit individuals were more likely to opt out. In the initial contact with sampled households, potential respondents were told that they would be asked to visit an examination centre where their fitness levels and other health measures would be assessed. Thus, because of the specific nature of the survey (a heath *measures* survey), less fit individuals may have been particularly likely to be non-respondents at all three levels.

To partially assess this possibility, obesity estimates from the 2007-2009 CHMS were compared with those from the 2008 Canadian Community Health Survey (CCHS),[59] a general health survey that included measured height and weight. For adults aged 20 to 69 years, the estimated prevalence of obesity based on 2008 CCHS data was 25.4% (unpublished tabulation), not significantly different from the CHMS estimate of 24.3%. Therefore, at least for estimates of BMI, no evidence suggests that the specific nature of the CHMS had an impact on survey estimates.

The same concerns also apply to 1981 CFS estimates. Based on CFS data, 8.9% (95% confidence interval: 8.0% to 9.9%) of adults aged 20 to 69 years were obese in 1981, somewhat below the estimate of 13.0% (95% confidence interval: 11.6% to 14.4%) based on data from the Canada Health Survey (CHS) of 1978/79.[60] If the CHS is the more accurate of the two surveys, estimates of the decline in morphological fitness levels reported in this paper may be somewhat exaggerated.

As much as possible, the CHMS fitness tests and anthropometric measures were selected for their similarity to those in the CFS. However, differences in the methodology of the sample design, in educational and training requirements of survey administrators, in response rates and in weighting procedures may have weakened the comparability of survey estimates.

Conclusion

This paper presents the first comprehensive fitness assessment of Canadian adults in more than two decades. Overall, the prevalence of suboptimal fitness levels has increased markedly since 1981. Increases were

What is already known on this subject?

- Estimates of obesity based on body mass index (BMI) reveal that Canadian adults have become heavier over the past 25 years.
- Excess abdominal fat and elevated skinfold measurements are associated with adverse health outcomes, independent of BMI.
- Aerobic fitness is protective against disease, independent of BMI, and musculoskeletal fitness confers considerable health benefits, particularly at older ages.

What does this study add?

- The 2007-2009 Canadian Health Measures Survey provides objective data on fitness levels of the Canadian population for the first time in more than two decades.
- Mean scores for aerobic and musculoskeletal fitness were lower with advancing age in both sexes, while BMI, waist circumference and skinfold measurements rose at older ages.
- At ages 40 to 69 years, the percentage of males and females whose waist circumference placed them at a high risk for health problems more than doubled between 1981 and 2007-2009; at ages 20 to 39 years, percentages more than quadrupled.
- Between 1981 and 2007-2009, the percentage of Canadians aged 40 to 69 years categorized as fair or needing improvement according to their body composition (BMI, waist circumference and skinfold measurements) more than doubled. Among males aged 20 to 39 years, the increase was fourfold, and among younger females, sevenfold.
- The percentage of males and females with suboptimal health benefit ratings for muscular strength increased between 1981 and 2007-2009.

particularly pronounced for young adults, among whom the percentage with a waist circumference that placed them at a high risk for health problems more than quadrupled. Similarly, the percentage whose body composition was classified as “fair/needs improvement” rose fourfold among young males and sevenfold among young females. Increases in the percentage of young adults with suboptimal health benefit ratings of muscular strength and flexibility were also substantial. Longitudinal data reveal that once adults are overweight or obese, further weight gain is likely, and very few return to the normal weight range.[61] As these young adults with suboptimal fitness levels get older, commensurate increases in health risks and the resulting public health and economic burden of non-communicable disease are inevitable.

Data from future CHMS cycles will permit a closer and more regular assessment of temporal trends in all of the fitness measures presented here, and will allow for an ongoing assessment of intervention attempts to improve the fitness of the nation. ■

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Table A
Percentage distribution of response outcomes for fitness tests, by sex and age group, household population aged 20 to 69 years, Canada, March 2007 to February 2009

Fitness test, response outcome and sex	20 to 39 years	40 to 59 years	60 to 69 years
	%		
Aerobic fitness test (mCAFT)			
Screened in			
Test completed			
Male	88.2	72.4†	42.6†
Female	82.5*	70.9†	41.8†
Test not done: trouble maintaining cadence			
Male	1.1	0.8	0.0†
Female	2.5	0.2†	0.3†
Test not done: other reason‡			
Male	1.3	0.4	0.4
Female	0.4	2.3*	2.0
Screened out			
Male	9.4	26.4†	57.0†
Female	14.6*	26.6†	55.9†
Flexibility test (sit-and-reach)			
Screened in			
Test completed			
Male	98.0	95.6	96.0
Female	95.7	96.4	91.7*
Test not done			
Male	0.7	1.7	1.2
Female	0.3	1.3	2.9†
Screened out			
Male	1.3	2.7	2.7
Female	4.0	2.3	5.4
Muscular endurance (partial curl-ups)			
Screened in			
Test completed			
Male	88.7	85.0†	81.1†
Female	88.8	81.5†	73.6†
Test not done			
Male	1.3	1.4	1.7
Female	1.5	1.8	2.2
Screened out			
Male	10.0	13.6†	17.2†
Female	9.7	16.7†	24.1†
Muscular strength (grip strength)			
Screened in			
Test completed			
Male	98.1	99.8	98.7
Female	99.8	99.3	99.3
Test not done			
Male	1.8	0.0	1.0
Female	0.1	0.4	0.2
Screened out			
Male	0.1	0.2	0.3
Female	0.1	0.3	0.5

* significantly different from estimate for males ($p < 0.05$)
† significantly different from estimate for 20- to 39-year-olds ($p < 0.05$)
‡ includes refusal, home inteview and other reasons
Source: 2007-2009 Canadian Health Measures Survey.

Table B
Percentage screened out of aerobic fitness tests, by sex and age group, household population aged 20 to 69 years, Canada, 1981 and 2007-2009

Sex and survey year	20 to 39 years	40 to 59 years	60 to 69 years
	%		
Male			
1981	9.0	27.2	51.0
2007-2009	9.4	26.4	57.0
Female			
1981	13.7	31.4	59.1
2007-2009	14.6	26.6	55.9

Note: Differences in estimates between 1981 and 2007-2009 were not significant ($p < 0.05$)
Source: 1981 Canada Fitness Survey; 2007-2009 Canadian Health Measures Survey.

Table C
Sample sizes for fitness assessments, by age group and sex, household population aged 20 to 69 years, Canada, March 2007 to February 2009

Fitness assessment	20 to 39 years		40 to 59 years		60 to 69 years	
	Male	Female	Male	Female	Male	Female
Total sample	**524**	**661**	**582**	**654**	**342**	**339**
Total sample with score assigned for:						
Aerobic fitness (mCAFT)	466	534	418	480	150	146
Flexibility (sit-and-reach)	515	630	560	630	319	311
Muscular endurance (partial curl-ups)	480	580	492	552	268	252
Muscular strength (grip strength)	517	656	581	648	336	335
Total sample with measurements taken for:						
Body mass index	524	633	582	654	342	337
Waist circumference	524	631	581	652	341	337
Sum of five skinfolds†	412	495	418	486	229	216

† excludes respondents with BMI 30.0 kg/m^2 or higher
Source: 2007-2009 Canadian Health Measures Survey.