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by Jonathon Fowles, Joel Roy, Janine Clarke and Shilpa Dogra

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Are the fittest Canadian adults the healthiest?

by Jonathon Fowles, Joel Roy, Janine Clarke and Shilpa Dogra

Abstract

Data from the Canadian Health Measures Survey (cycles 1 and 2) were analyzed to determine if higher fitness categories are associated with better health. Respondents' fitness was assessed in terms of cardiorespiratory fitness, grip strength, sit-and-reach and partial curl-ups, and also according to two composite measures (back fitness and musculoskeletal fitness). Fitness scores could range from "Needs improvement" to "Excellent." Pairwise t-tests were used to compare health outcomes across fitness categories. The health outcomes were waist circumference, blood pressure, glycated hemoglobin, ratio of total cholesterol to high-density lipoprotein, lung function, self-rated health, life satisfaction, and number of chronic conditions. All health outcomes except systolic blood pressure were significantly better among respondents whose cardiorespiratory fitness was "Excellent," compared with "Needs improvement." For grip strength and partial curl-ups, only glycated hemoglobin and self-rated health were better among respondents in the "Excellent" category, compared with "Needs improvement." Lung function was worse in those with better grip strength. No significant associations with health outcomes emerged for sit-and-reach.

Keywords

Cardiovascular disease, cardiorespiratory fitness, cholesterol, diabetes, lung function, obesity, quality of life

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The link between fitness and disease and disability is well established.[1-3] Accordingly, fitness assessments are used to estimate health risk in the general population. Although such assessments are typically less strenuous than those employed to ascertain performance-related fitness, the results allow for an individual's fitness level to be placed in categories such as poor, fair, good, very good or excellent.[4] It is generally assumed that people in the highest fitness categories are the healthiest.

Epidemiological studies that have found fitness to be associated with morbidity and mortality[5-7] typically divide fitness scores of the sample into quintiles or quartiles rather than using normative data for placement into categories. Such research is, therefore, unable to determine if people who have excellent or very good fitness are, in fact, healthier than people in lower fitness categories.

The present analysis examines associations between the results of a standard fitness appraisal and selected health outcomes among Canadians aged 15 to 69 (see *The data*). The aim is to determine if people in higher fitness categories are, indeed, healthier than those in lower categories.

Cardiorespiratory fitness

Cardiorespiratory fitness is a strong and independent predictor of morbidity and mortality.[5-7] In the present study, respondents whose cardiorespiratory fitness scores were in higher categories generally had better health outcomes. All outcomes except lung function (FEV_1/FVC) were significantly better among those whose cardiorespiratory fitness was "Excellent," compared with those whose scores put them in the "Needs improvement" category; this was also true for most health outcomes among those whose cardiorespiratory fitness was "Very good" (Table 1). With further adjustment for waist circumference, systolic blood pressure was no longer significantly lower among respondents with "Excellent" cardiorespiratory fitness, compared with "Needs improvement" (Table 2). Few differences in health outcomes emerged between respondents in the "Needs improvement" cardiorespiratory fitness category and those in the "Fair" or "Good" categories.

The data

Data for this study are from the combined cycles 1 (March 2007 to February 2009) and 2 (August 2009 to November 2011) of the Canadian Health Measures Survey (CHMS). The CHMS covers 96% of the Canadian population aged 6 to 79. It excludes people living on reserves and in other Aboriginal settlements, full-time members of the Canadian Forces, institutionalized individuals, and residents of certain remote areas.[8,9] Data collection was completed in two steps: an interview at the respondent's home and a visit to the CHMS mobile examination centre where physical measurements and blood and urine samples were taken.

The overall response rate for both cycles was 53.5% of selected households.[10] Ethics approval for the CHMS was obtained from Health Canada's Research Ethics Board; informed, written consent was obtained from all participants aged 14 or older.[11] This study is based on 7,605 respondents aged 15 to 69 (mean age = 40; 47% male, 53% female) for whom various fitness measurements and health outcomes were obtained. This age range was chosen based on the validity of exercise pre-screening and exercise testing protocols.

Cardiorespiratory fitness (modified Canadian Aerobic Fitness Test, mCAFT), flexibility (sit-and-reach), muscle endurance (partial curl-ups) and strength (grip strength) assessments were performed using protocols outlined in the Canadian Physical Activity, Fitness and Lifestyle Approach (CPAFLA) of the Canadian Society for Exercise Physiology (CSEP).[12] The CSEP has since published an updated, evidence-based manual that will be used to guide future data collection.[4] Test eligibility for the musculoskeletal measures was established based on medication use, the presence of acute and chronic conditions, pregnancy, and failure to adhere to pre-testing guidelines.[8,10]

The CHMS used strict screening criteria for the various fitness tests, particularly, the mCAFT and partial curl-up, in which respondents with high blood pressure or who were taking blood pressure medication or who had had a heart attack did not participate. Consequently, people who participated in some of the fitness tests were inherently healthier than those who did not.

Waist circumference was measured at the highest lateral point of the iliac crest, as described in the National Institutes of Health protocols.[13]

Composite scores for *back fitness* and for *musculoskeletal fitness* were calculated according to the CPAFLA. Waist circumference and partial curl-ups were used for back fitness. Grip strength, sit-and-reach and partial curl-ups were used for musculoskeletal fitness. In the updated CSEP manual, composite scores are no longer used.[4]

For each respondent, an automated device (BPTru™ BP-300 device, BpTRU Medical Devices Ltd., Coquitlam, British Columbia) recorded a minimum of six blood pressure and heart rate measurements taken at one-minute intervals following a five-minute rest period. Resting averages were then calculated based on the last five of these measurements.

Up to eight trials of a full inspiration followed by a full and forceful expiration through a Koko spirometer (nSpire Health, Inc., 908 Main Street, Louisville, CO 80027 USA) were used to measure lung function. The best forced vital capacity (FVC) and the best forced expiratory volume in one second (FEV_1) from trials meeting the American Thoracic Society standards for within- and between-manoeuvre criteria[14] were maintained for each respondent. The FEV_1/FVC ratio was then calculated.

Venous blood samples were collected. Total cholesterol (TC) and high-density lipoprotein (HDL) were measured in serum. The total cholesterol-to-high-density lipoprotein (TC/HDL) ratio was used for analysis. Glycated hemoglobin (HbA1c) was measured in whole blood.

As part of the household interview, respondents were asked to rate their general health (excellent, very good, good, fair or poor) and their level of life satisfaction (very satisfied, satisfied, neither satisfied nor dissatisfied, dissatisfied or very dissatisfied). Those who selected excellent, very good or good for their general health were considered to have a positive view; those who selected very satisfied or satisfied for their level of life satisfaction were categorized as being generally satisfied with their life.

Respondents were asked if they had physician-diagnosed chronic health conditions: arthritis, cardiovascular disease (heart disease or stroke), hypertension, chronic obstructive pulmonary disease, and diabetes.

Respondents were asked what prescription and over-the-counter medications they had taken in the last month.[8,10] Drug identification numbers were used to find the corresponding code in the Anatomical Therapeutic Chemical (ATC) classification system[15] to identify medication use related to each selected health outcome. Reported chronic conditions and medication use were used in conjunction with directly measured values to determine the presence of a chronic condition or health risk: cardiovascular (self-reported heart disease, hypertension or stroke; medication for blood pressure or blood lipids; or systolic BP ≥ 130 mmHg or diastolic BP ≥ 85 mmHg); respiratory (self-reported asthma, emphysema, chronic obstructive pulmonary disease, chronic bronchitis; medication for respiratory conditions; or $FEV_1/FVC < 70\%$); metabolic (self-reported diabetes; medication for diabetes; or HbA1c ≥ 7.0%); and musculoskeletal (self-reported arthritis or arthritis medications). A variable was also created to identify respondents who had at least one of these chronic conditions/risks.

Linear regression was used to assess whether higher fitness categories were independently associated with better health outcomes, adjusting first for age group and sex (Table 1), and then for waist circumference (Table 2), which was significantly associated with the exposures (fitness measures) and also with the health outcomes. Finally, t-tests were run to determine differences in adjusted estimates across fitness categories.

The analyses were completed with SAS v9.2 and SUDAAN v10. Results were weighted using the full sample weights for the combined cycle 1 and 2 data. Confidence intervals were calculated with the bootstrap technique. Differences between estimates were based on a reference value of $p < 0.005$. The combined cycle 1 and 2 CHMS study design requires that 24 degrees of freedom be specified in the software (11 degrees of freedom in cycle 1 plus 13 degrees of freedom in cycle 2).[8-10] Differences across fitness categories were not assessed for minimal clinically important differences; these data do not exist for CPAFLA measures.

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Table 1
Mean or prevalence of selected health outcomes adjusted for age and sex, by fitness norm category, household population aged 15 to 69, Canada, 2007 to 2011

	Fitness norm category														
	Needs improvement			Fair			Good			Very good			Excellent		
	Mean / Prevalence	95% confidence interval		Mean / Prevalence	95% confidence interval		Mean / Prevalence	95% confidence interval		Mean / Prevalence	95% confidence interval		Mean / Prevalence	95% confidence interval	
Fitness norm/Health outcome		from	to		from	to		from	to		from	to		from	to
Cardiorespiratory fitness															
Waist (cm)	103.1	101.3	105.0	91.5*†	90.5	92.5	86.2*†	85.2	87.2	82.5*†	81.6	83.5	80.8*	79.2	82.3
Systolic BP (mmHg)	112.0	110.0	113.0	110.0*†	109.0	111.0	108.0*	107.0	109.0	106.0*	105.0	107.0	106.0*	103.0	109.0
Diastolic BP (mmHg)	72.0	71.0	73.0	71.0	71.0	72.0	71.0	70.0	72.0	69.0*	68.0	70.0	67.0*	65.0	70.0
HbA1c	5.7	5.6	5.8	5.6	5.5	5.7	5.5	5.4	5.6	5.5*	5.4	5.6	5.4*	5.3	5.5
TC/HDL	4.3	4.2	4.4	4.0*†	3.9	4.1	3.7*†	3.6	3.8	3.5*†	3.4	3.6	3.1*†	2.9	3.3
FEV$_1$/FVC	78.3	77.6	79.1	79.1	78.4	79.7	78.8	78.2	79.4	78.8	77.9	79.6	79.6	78.8	80.3
Good/Very good/Excellent self-rated health (%)	87.7	84.3	91.0	93.9	91.4	96.5	96.2*	94.4	98.0	97.6*	95.5	99.8	99.2*	98.3	100.2
Satisfied/Very satisfied with life (%)	88.5	84.9	92.1	91.2	87.7	94.8	93.5	91.8	95.2	91.7	88.8	94.6	96.8*	95.1	98.4
Chronic condition (%)	48.2	42.0	54.4	39.5	34.2	44.8	34.4*	30.4	38.4	32.1*	26.8	37.4	26.8*	18.5	35.0
Grip strength															
Waist (cm)	89.6	88.3	90.9	90.4	88.8	92.0	91.2	90.1	92.3	94.5*	92.4	96.6	95.9*	94.2	97.6
Systolic BP (mmHg)	109.0	108.0	110.0	111.0	109.0	113.0	111.0	110.0	112.0	112.0*	110.0	113.0	111.0	110.0	113.0
Diastolic BP (mmHg)	71.0	70.0	71.0	72.0	70.0	73.0	71.0	70.0	72.0	72.0	71.0	73.0	72.0	71.0	72.0
HbA1c	5.7	5.6	5.8	5.6	5.5	5.7	5.6	5.5	5.7	5.6	5.5	5.7	5.6	5.5	5.7
TC/HDL	3.8	3.7	3.9	3.7	3.6	3.9	3.9	3.7	4.0	4.0	3.8	4.1	4.0*	3.9	4.2
FEV$_1$/FVC	79.0	78.4	79.5	78.3	77.8	78.9	78.1	77.4	78.9	78.2	77.6	78.8	77.7*	76.9	78.4
Good/Very good/Excellent self-rated health (%)	86.3	83.9	88.8	89.8	87.0	92.6	91.9*	89.7	94.0	93.4*	91.2	95.5	92.2	88.6	95.7
Satisfied/Very satisfied with life (%)	87.6	85.2	89.9	87.5	83.9	91.1	89.2	85.7	92.6	91.0	88.6	93.4	92.0	88.9	95.1
Chronic condition (%)	49.2	44.7	53.7	46.9	42.8	51.0	45.9	42.5	49.2	44.0	39.1	48.8	48.6	43.2	54.1
Sit-and-reach															
Waist (cm)	94.7	92.9	96.4	93.0	91.8	94.2	90.5*†	89.4	91.7	88.2*	86.8	89.6	85.0*†	84.0	85.9
Systolic BP (mmHg)	111.0	110.0	112.0	110.0	109.0	112.0	110.0	109.0	112.0	111.0	108.0	113.0	109.0	107.0	111.0
Diastolic BP (mmHg)	71.0	70.0	72.0	71.0	70.0	72.0	71.0	70.0	72.0	72.0	70.0	74.0	71.0	70.0	72.0
HbA1c	5.7	5.6	5.8	5.6	5.6	5.7	5.6	5.5	5.8	5.6	5.5	5.7	5.5*	5.4	5.6
TC/HDL	4.0	3.8	4.1	3.9	3.8	4.1	3.9	3.8	4.0	3.8	3.6	3.9	3.6*	3.4	3.8
FEV$_1$/FVC	78.9	78.3	79.6	78.3	77.8	78.8	78.3	77.7	78.9	77.9	77.2	78.5	78.2	77.3	79.0
Good/Very good/Excellent self-rated health (%)	87.9	85.6	90.2	92.3	90.3	94.3	89.0	85.6	92.4	95.1*	92.8	97.4	94.6*	91.2	97.9
Satisfied/Very satisfied with life (%)	88.4	85.6	91.1	88.8	85.5	92.1	90.5	87.7	93.3	90.5	86.7	94.2	91.4	87.7	95.0
Chronic condition (%)	47.0	42.8	51.3	44.8	39.9	49.6	47.6	43.5	51.7	44.8	40.1	49.6	42.3	36.6	48.1
Partial curl-up															
Waist (cm)	96.4	94.9	97.8	90.3*†	87.4	93.2	88.2*	86.4	89.9	88.2*	87.0	89.3	85.6*†	84.5	86.7
Systolic BP (mmHg)	110.0	109.0	112.0	110.0	108.0	112.0	108.0	107.0	110.0	108.0*	107.0	109.0	109.0	107.0	110.0
Diastolic BP (mmHg)	71.0	71.0	72.0	71.0	70.0	73.0	70.0	69.0	71.0	70.0	69.0	71.0	70.0	69.0	71.0
HbA1c	5.7	5.6	5.8	5.7	5.5	5.9	5.5*	5.4	5.6	5.5*	5.4	5.6	5.5*	5.4	5.6
TC/HDL	4.0	3.9	4.1	3.9	3.7	4.1	3.7*	3.6	3.8	3.8	3.6	4.0	3.6*	3.5	3.7
FEV$_1$/FVC	79.0	78.4	79.5	79.2	77.9	80.5	78.0	77.3	78.7	78.2	77.4	79.1	78.1	77.6	78.6
Good/Very good/Excellent self-rated health (%)	89.0	86.6	91.4	93.3	88.5	98.0	92.0	87.5	96.6	96.3*	94.0	98.5	96.7*	95.3	98.2
Satisfied/Very satisfied with life (%)	90.1	88.0	92.2	89.7	83.9	95.6	89.5	84.0	95.1	90.6	86.5	94.8	93.9	92.1	95.6
Chronic condition (%)	46.5	42.5	50.5	49.2	41.1	57.2	40.9	33.1	48.7	38.3*	34.5	42.1	40.0	35.6	44.4
Back fitness															
Waist (cm)‡	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Systolic BP (mmHg)	114.0	113.0	115.0	112.0*†	111.0	113.0	109.0*†	108.0	110.0	109.0*	108.0	110.0	110.0*	108.0	112.0
Diastolic BP (mmHg)	73.0	72.0	73.0	73.0	72.0	74.0	71.0*†	70.0	71.0	70.0*	70.0	71.0	71.0	69.0	73.0
HbA1c	5.9	5.8	6.0	5.7*†	5.6	5.8	5.6*	5.5	5.7	5.5*	5.4	5.6	5.5*	5.4	5.6
TC/HDL	4.4	4.3	4.6	4.1*†	4.0	4.2	3.8*†	3.7	3.9	3.6*†	3.5	3.7	3.4*†	3.3	3.5
FEV$_1$/FVC	79.1	78.4	79.8	79.0	78.2	79.8	78.4	77.9	79.0	77.8*	77.3	78.3	77.5*	76.7	78.2
Good/Very good/Excellent self-rated health (%)	80.5	77.6	83.5	88.5*†	85.7	91.2	92.1*	89.7	94.6	93.5*	92.1	95.0	93.9*	90.8	96.9
Satisfied/Very satisfied with life (%)	84.8	81.1	88.4	88.4	85.1	91.7	89.5	86.8	92.2	89.7	87.9	91.5	92.2*	88.6	95.7
Chronic condition (%)	61.4	57.4	65.4	48.5*†	44.3	52.6	44.3*	38.8	49.9	41.0*	37.3	44.8	44.2*	38.2	50.1

Table 1 (continued)
Mean or prevalence of selected health outcomes adjusted for age and sex, by fitness norm category, household population aged 15 to 69, Canada, 2007 to 2011

Fitness norm/Health outcome	Needs improvement			Fair			Good			Very good			Excellent		
	Mean / Prevalence	95% confidence interval		Mean / Prevalence	95% confidence interval		Mean / Prevalence	95% confidence interval		Mean / Prevalence	95% confidence interval		Mean / Prevalence	95% confidence interval	
		from	to		from	to		from	to		from	to		from	to
Musculoskeletal fitness															
Waist (cm)	95.1	93.4	96.9	91.9*†	90.4	93.5	91.8*	90.1	93.4	90.4*	89.3	91.5	88.4*	86.5	90.3
Systolic BP (mmHg)	110.0	109.0	112.0	110.0	109.0	111.0	111.0	110.0	113.0	111.0	110.0	113.0	110.0	108.0	112.0
Diastolic BP (mmHg)	71.0	70.0	73.0	71.0	70.0	72.0	72.0	71.0	73.0	72.0	71.0	73.0	70.0	69.0	72.0
HbA1c	5.8	5.6	5.9	5.7	5.6	5.8	5.6*	5.5	5.7	5.6*	5.5	5.7	5.5*	5.4	5.6
TC/HDL	4.0	3.9	4.1	3.9	3.8	4.0	3.9	3.7	4.0	3.8	3.7	4.0	3.8	3.5	4.0
FEV$_1$/FVC	78.9	78.2	79.7	78.8	78.2	79.3	78.3	77.8	78.7	77.9	77.2	78.6	76.7	75.0	78.3
Good/Very good/Excellent self-rated health (%)	83.0	78.6	87.3	88.6	86.8	90.4	91.8*	89.9	93.7	94.3*	92.3	96.2	93.7*	89.4	98.0
Satisfied/Very satisfied with life (%)	84.1	79.7	88.6	88.5	86.0	91.0	89.5	87.0	92.1	92.8*	90.9	94.6	88.5	81.7	95.2
Chronic condition (%)	55.3	50.3	60.2	45.9*†	41.9	50.0	45.7	41.3	50.1	46.9	43.4	50.4	40.2	29.5	50.8

BP = blood pressure
HbA1c = glycated hemoglobin
TC/HDL = total cholesterol/high-density lipoprotein
FEV$_1$ = forced expiratory volume in one second
FVC = forced vital capacity
* significantly different from Needs improvement (p < 0.005)
† significantly different from preceding category (p < 0.005)
‡ waist circumference not presented as health outcome because it is used to calculate back fitness
… not applicable
Source: 2007 to 2009 and 2009 to 2011 Canadian Health Measures Survey, combined.

Grip strength

Grip strength is associated with functional autonomy among older adults.[16] However, according to data from the CHMS, results for waist circumference, total cholesterol/high-density lipoprotein (TC/HDL) and lung function were not as favourable among respondents whose grip strength was "Excellent" versus "Needs improvement" (Table 1). For instance, respondents whose waist circumference was large enough to be associated with increased health risks[17] had significantly greater (p < 0.005) grip strength (73 kg versus 70 kg) than did those with a smaller waist (data not shown).

These results may reflect the association between grip strength and body mass. Since Force = Mass*Acceleration, a higher body mass (as indicated by a larger waist) would mean greater grip strength. When waist circumference was taken into account, glycated hemoglobin (HbA1c) results were better, and the prevalence of positive self-rated health was higher, among respondents with

"Excellent" grip strength, compared with those whose grip strength was categorized as "Needs improvement"; lung function, however, was still worse for those in the "Excellent" category (Table 2).

Results of grip strength assessments should be interpreted cautiously and in the context of waist circumference, which is negatively associated with some health outcomes.

Trunk flexibility

Trunk flexibility is associated with low back pain[18] and other musculoskeletal morbidities.[19] When age group and sex were taken into account, results for waist circumference, HbA1c, TC/HDL, and positive self-rated health were significantly better among respondents who had "Excellent" sit-and-reach scores, compared with those whose scores were in the "Needs improvement" category (Table 1). However, when further controlling for waist circumference, no significant associations remained between trunk flexibility and any of the health outcomes (Table 2).

Thus, when waist circumference is taken into account, trunk flexibility does not seem to be associated with the health outcomes examined in this study.

Abdominal muscular endurance

Like trunk flexibility, abdominal muscular endurance is related to low back pain[20] and musculoskeletal morbidities.[19] CHMS data adjusted for age and sex suggest that respondents with "Excellent" abdominal muscular endurance had better outcomes for waist circumference, HbA1c, TC/HDL and self-rated health than did those whose muscular endurance was categorized as "Needs improvement" (Table 1). But when waist circumference was also considered, only HbA1c and the prevalence of positive self-rated health differed significantly between those whose abdominal muscular endurance was classified as "Excellent" versus "Needs improvement."

It should be noted that the distribution of the results of the partial curl-up assessment were bimodal—most respondents

Table 2
Mean or prevalence of selected health outcomes adjusted for age, sex and waist circumference, by fitness norm category, household population aged 15 to 69, Canada, 2007 to 2011

Fitness norm/Health outcome	Needs improvement Mean / Prevalence	95% confidence interval from	to	Fair Mean / Prevalence	95% confidence interval from	to	Good Mean / Prevalence	95% confidence interval from	to	Very good Mean / Prevalence	95% confidence interval from	to	Excellent Mean / Prevalence	95% confidence interval from	to
Cardiorespiratory fitness															
Systolic BP (mmHg)	111.0	109.0	112.0	109.0	108.0	110.0	108.0	107.0	110.0	107.0*	106.0	108.0	107.0	104.0	110.0
Diastolic BP (mmHg)	72.0	71.0	73.0	71.0	70.0	72.0	71.0	70.0	72.0	69.0	68.0	70.0	68.0*	66.0	70.0
HbA1c	5.7	5.5	5.8	5.6	5.5	5.7	5.5	5.5	5.6	5.5*	5.4	5.6	5.4*	5.3	5.5
TC/HDL	4.0	3.9	4.1	3.9	3.8	4.0	3.8	3.7	3.9	3.7*	3.5	3.8	3.3*†	3.1	3.5
FEV$_1$/FVC	78.0	77.2	78.8	79.0	78.3	79.7	78.9	78.3	79.5	79.0	78.0	79.9	79.8*	79.1	80.5
Good/Very good/Excellent self-rated health (%)	88.5	85.0	92.0	94.2	91.6	96.7	96.0*	94.2	97.7	97.1*	94.7	99.5	98.7*	97.6	99.8
Satisfied/Very satisfied with life (%)	88.8	84.9	92.6	91.3	87.7	94.9	93.4	91.7	95.1	91.5	88.5	94.5	96.6*	94.7	98.4
Chronic condition (%)	46.2	40.1	52.2	39.0	33.6	44.3	35.1*	31.1	39.1	33.4*	28.2	38.7	28.2*	19.9	36.4
Grip strength															
Systolic BP (mmHg)	109.0	108.0	111.0	111.0	109.0	113.0	111.0	110.0	112.0	111.0	110.0	113.0	111.0	110.0	112.0
Diastolic BP (mmHg)	71.0	70.0	72.0	72.0	70.0	73.0	71.0	70.0	72.0	72.0	70.0	73.0	71.0	71.0	72.0
HbA1c	5.7	5.6	5.8	5.6	5.6	5.7	5.6	5.5	5.7	5.6	5.5	5.7	5.6*	5.5	5.7
TC/HDL	3.9	3.8	4.0	3.8	3.7	3.9	3.9	3.8	4.0	3.9	3.8	4.0	4.0	3.8	4.1
FEV$_1$/FVC	79.0	78.5	79.6	78.4	77.8	78.9	78.1	77.4	78.9	78.1	77.5	78.8	77.6*	76.8	78.3
Good/Very good/Excellent self-rated health (%)	86.0	83.5	88.4	89.4	86.6	92.2	91.6*	89.6	93.6	94.0*	91.9	96.1	93.0*	89.7	96.3
Satisfied/Very satisfied with life (%)	87.4	85.1	89.7	87.4	83.7	91.0	89.1	85.7	92.5	91.2	88.8	93.7	92.3	89.2	95.4
Chronic condition (%)	49.9	45.8	54.1	47.5	43.4	51.6	46.3	43.2	49.4	42.8	38.2	47.3	47.2	41.7	52.6
Sit-and-reach															
Systolic BP (mmHg)	110.0	109.0	111.0	110.0	109.0	112.0	110.0	109.0	112.0	111.0	109.0	113.0	110.0	108.0	112.0
Diastolic BP (mmHg)	71.0	70.0	72.0	71.0	70.0	72.0	71.0	70.0	72.0	72.0	70.0	74.0	71.0	70.0	72.0
HbA1c	5.7	5.6	5.8	5.6	5.5	5.7	5.6	5.5	5.8	5.6	5.5	5.7	5.6	5.5	5.6
TC/HDL	3.9	3.8	4.0	3.9	3.8	4.0	3.9	3.8	4.0	3.8	3.7	4.0	3.8	3.6	3.9
FEV$_1$/FVC	78.9	78.2	79.6	78.3	77.8	78.8	78.3	77.7	78.9	77.9	77.2	78.6	78.3	77.4	79.1
Good/Very good/Excellent self-rated health (%)	88.4	86.1	90.8	92.5	90.7	94.3	89.1	85.8	92.3	94.5*	92.3	96.7	93.5	90.1	96.8
Satisfied/Very satisfied with life (%)	88.5	85.8	91.3	88.9	85.6	92.1	90.5	87.7	93.4	90.3	86.6	94.0	91.0	87.2	94.8
Chronic condition (%)	45.7	41.9	49.6	44.3	39.5	49.1	47.5	43.3	51.6	46.2	41.4	51.1	45.1	39.5	50.8
Partial curl-up															
Systolic BP (mmHg)	110.0	109.0	111.0	110.0	108.0	112.0	109.0	107.0	110.0	108.0	107.0	109.0	110.0	108.0	111.0
Diastolic BP (mmHg)	71.0	70.0	72.0	71.0	70.0	73.0	70.0	69.0	72.0	70.0	70.0	71.0	71.0	70.0	72.0
HbA1c	5.7	5.6	5.8	5.7	5.5	5.9	5.6	5.5	5.7	5.5*	5.5	5.6	5.5*	5.4	5.6
TC/HDL	3.9	3.8	4.0	3.9	3.7	4.1	3.7	3.6	3.9	3.8	3.6	4.0	3.7	3.6	3.8
FEV$_1$/FVC	78.9	78.4	79.5	79.2	77.9	80.5	78.0	77.4	78.7	78.3	77.4	79.1	78.1	77.6	78.7
Good/Very good/Excellent self-rated health (%)	89.9	87.6	92.2	93.2	88.3	98.0	91.6	86.9	96.2	95.8*	93.5	98.2	95.8*	94.3	97.3†
Satisfied/Very satisfied with life (%)	90.2	88.1	92.3	89.7	83.8	95.6	89.5	83.8	95.1	90.5	86.4	94.7	93.7	91.9	95.5
Chronic condition (%)	44.3	40.4	48.1	49.4	41.2	57.7	42.1	34.7	49.5	39.4	35.6	43.3	42.2	37.9	46.6
Musculoskeletal fitness															
Systolic BP (mmHg)	110.0	109.0	111.0	110.0	109.0	111.0	111.0	110.0	112.0	111.0	110.0	113.0	110.0	108.0	112.0
Diastolic BP (mmHg)	71.0	70.0	72.0	71.0	70.0	71.0	72.0	71.0	72.0	72.0	71.0	73.0	71.0	69.0	73.0
HbA1c	5.7	5.6	5.9	5.7	5.6	5.8	5.6	5.5	5.7	5.6*	5.5	5.7	5.5*	5.4	5.6
TC/HDL	3.9	3.8	4.0	3.9	3.8	3.9	3.9	3.8	4.0	3.9	3.7	4.0	3.9	3.6	4.1
FEV$_1$/FVC	78.9	78.1	79.6	78.7	78.2	79.3	78.3	77.8	78.7	77.9	77.2	78.6	76.7	75.1	78.4
Good/Very good/Excellent self-rated health (%)	83.5	79.2	87.8	88.8	86.9	90.6	91.8*	89.9	93.6	93.9*	92.0	95.9	92.9*	88.6	97.1
Satisfied/Very satisfied with life (%)	84.3	79.9	88.7	88.6	86.0	91.1	89.5	86.9	92.1	92.6*	90.8	94.5	88.2	81.4	95.0
Chronic condition (%)	54.1	49.1	59.1	45.6	41.8	49.4	45.8	41.6	49.9	47.6	44.0	51.2	41.9	31.1	52.6

BP = blood pressure
HbA1c = glycated hemoglobin
TC/HDL = total cholesterol/high-density lipoprotein
FEV$_1$ = forced expiratory volume in one second
FVC = forced vital capacity
* significantly different from Needs improvement (p < 0.005)
† significantly different from preceding category (p < 0.005)
Note: Back fitness is not presented because the composite score is based on only two measures, one of which is waist circumference.
Source: 2007 to 2009 and 2009 to 2011 Canadian Health Measures Survey, combined.

were either in the "Needs improvement" or "Excellent" categories[21,22]; this may be explained by the complexity of the test (technique and/or cadence). Because of the bimodal distribution and the lack of association with health outcomes, this testing protocol has been removed from the updated CSEP manual.[4] Other protocols such as the front plank or side-support may be better-suited for assessing abdominal muscular endurance in the general population; however, further research is required.

Composite scores for back fitness and musculoskeletal fitness

Among respondents whose back fitness was "Excellent," results for all health outcomes except diastolic blood pressure were better than among those whose back fitness was categorized as "Needs improvement." Similarly, respondents with "Excellent" musculoskeletal fitness had better results for waist circumference, HbA1c and self-rated health than did those whose musculoskeletal fitness was categorized as "Needs improvement"; the relationship with HbA1c and self-rated health remained when adjusting for waist circumference.

Conclusion

The current analysis generally indicates an association between measured fitness levels, particularly, cardiorespiratory fitness, and various health outcomes. However, the association seems to hold only at the highest levels of fitness ("Excellent" or "Very good"), not at intermediate levels ("Good" and "Fair"), when compared with people in the "Needs improvement" category. The study suggests that fitness assessment results must be contextualized for specific health outcomes; higher fitness scores may be positively associated with certain health outcomes, but negatively associated with others. These negative associations may be mediated by body composition. ■

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