

## Introduction

Weakness, as often measured by handgrip strength, is associated with many health problems.

New absolute and body size normalized cut-points can be used individually or collectively for defining weakness.

The prevalence and trends for weakness in the United States is not well-understood.

**We sought to estimate the prevalence and trends of weakness in Americans aged at least 50-years.**

## Methods

### Participants

The analytic sample included 22,895 Americans aged at least 50-years with handgrip strength measured from the 2006-2016 waves of the Health and Retirement Study.

The Health and Retirement Study utilizes a longitudinal-panel design for monitoring health-related factors in Americans during aging.

Written informed consent was acquired from all participants and protocols were approved by the University's Behavioral Sciences Committee Institutional Review Board.

### Measures

Handgrip strength was measured with a handgrip dynamometer. Two measures were completed on each hand, alternating between hands, and the highest handgrip strength recorded was included in the analyses.

Men with handgrip strength <35.5-kg (absolute), <0.45 kg/kg (normalized to body weight), or <1.05 kg/kg/m<sup>2</sup> (normalized to body mass index) were classified as weak; whereas, females with handgrip strength <20.0-kg, <0.34 kg/kg, or <0.79 kg/kg/m<sup>2</sup> were considered weak.

Participants self-reported their age and sex.

### Statistical Analysis

Analyses were performed with SAS 9.4 software (SAS; Cary, NC).

Population weights were utilized for generating prevalence estimates for weakness that were nationally-representative.

The prevalence of weakness was presented as 1) having any weakness, and 2) being below 1, 2, or all 3 handgrip strength cut-points.

Prevalence estimates were shown as overall, and stratified by age group and sex for each combined Health and Retirement Study wave (2006-2008; 2010-2012; 2014-2016).

## Results

**Table 1.** Unweighted Descriptive Characteristics of the Participants.

	Total Sample (n=22,895)	2006-2008 Waves (n=13,572)	2010-2012 Waves (n=15,904)	2014-2016 Waves (n=14,965)
Age (years)	64.4±10.5	68.5±9.9	66.3±10.7	66.9±10.6
Age Group (n (%))				
Middle-Aged Adult (n (%))	12,589 (55.0)	4,866 (35.9)	7,812 (49.1)	7,211 (48.2)
Older Adult (n (%))	10,306 (45.0)	8,706 (64.1)	8,092 (50.9)	7,754 (51.8)
Sex (n (%))				
Male	9,875 (43.1)	5,708 (42.1)	6,873 (43.2)	6,387 (42.7)
Female	13,020 (56.9)	7,864 (57.9)	9,031 (56.8)	8,578 (57.3)
Race and Ethnicity (n (%))				
Hispanic	2,944 (12.8)	1,147 (8.5)	1,926 (12.1)	2,103 (12.1)
Non-Hispanic Black	4,370 (19.1)	1,791 (13.2)	3,021 (19.0)	2,989 (20.0)
Non-Hispanic Other	14,769 (64.5)	288 (2.1)	494 (3.1)	9,266 (61.9)
Non-Hispanic White	812 (3.6)	10,346 (76.2)	10,463 (65.8)	607 (4.0)
BMI (kg/m <sup>2</sup> )	28.7±6.1	28.1±5.8	28.7±6.1	29.0±6.3
Body Mass (kg)	81.7±19.6	79.6±18.7	81.5±19.5	82.0±19.9

**Table 2.** Overall Estimated Prevalence of Weakness.

	Weighted Frequency	Weighted Prevalence	95% Confidence Interval
<b>2006-2008 Waves</b>			
Any Weakness	27,122,782	45.1	44.0, 46.0
1 Weakness Definition	10,235,402	17.0	16.2, 17.7
2 Weakness Definitions	9,391,082	15.6	14.9, 16.3
3 Weakness Definitions	7,496,298	12.5	11.8, 13.0
<b>2010-2012 Waves</b>			
Any Weakness	34,708,167	46.6	45.6, 47.5
1 Weakness Definition	12,984,933	17.4	16.6, 18.1
2 Weakness Definitions	12,058,784	16.2	15.4, 16.8
3 Weakness Definitions	9,664,450	13.0	12.3, 13.5
<b>2014-2016 Waves</b>			
Any Weakness	40,820,834	52.6	51.5, 53.7
1 Weakness Definition	14,848,912	19.1	18.2, 19.9
2 Weakness Definitions	14,088,374	18.2	17.3, 18.9
3 Weakness Definitions	11,883,548	15.3	14.6, 16.0

**Table 3.** Estimated Prevalence of Weakness by Age Group.

	Weighted Frequency	Weighted Prevalence	95% Confidence Interval
<b>Middle-Aged</b>			
<i>2006-2008 Waves</i>			
Any Weakness	10,146,358	32.7	31.2, 34.3
1 Weakness Definition	4,837,100	15.6	14.4, 16.8
2 Weakness Definitions	3,697,323	12.0	10.9, 12.9
3 Weakness Definitions	1,611,935	5.2	4.5, 5.9
<i>2010-2012 Waves</i>			
Any Weakness	14,723,932	34.9	33.5, 36.2
1 Weakness Definition	7,070,434	16.8	15.6, 17.8
2 Weakness Definitions	5,391,360	12.8	11.8, 13.7
3 Weakness Definitions	2,262,138	5.3	4.7, 5.9
<i>2014-2016 Waves</i>			
Any Weakness	17,245,485	42.2	40.6, 43.8
1 Weakness Definition	8,082,346	19.8	18.5, 21.0
2 Weakness Definitions	6,305,903	15.4	14.3, 16.5
3 Weakness Definitions	2,857,236	7.0	6.2, 7.7
<b>Older</b>			
<i>2006-2008 Waves</i>			
Any Weakness	16,976,424	58.1	46.9, 59.2
1 Weakness Definition	5,398,302	18.5	17.5, 19.3
2 Weakness Definitions	5,693,759	19.5	18.5, 20.4
3 Weakness Definitions	5,884,363	20.1	19.2, 21.0
<i>2010-2012 Waves</i>			
Any Weakness	19,984,235	61.9	60.4, 63.1
1 Weakness Definition	5,914,499	18.3	17.3, 19.3
2 Weakness Definitions	6,667,424	20.7	19.6, 21.6
3 Weakness Definitions	7,402,312	22.9	21.9, 23.9
<i>2014-2016 Waves</i>			
Any Weakness	23,575,349	64.2	62.8, 65.5
1 Weakness Definition	6,766,566	18.4	17.3, 19.4
2 Weakness Definitions	7,782,471	21.2	20.1, 22.2
3 Weakness Definitions	9,026,312	24.6	23.4, 25.6

## Results Continued

**Table 4.** Estimated Prevalence of Weakness by Sex.

	Weighted Frequency	Weighted Prevalence	95% Confidence Interval
<b>2006-2008 Waves (Females)</b>			
Any Weakness	15,459,229	47.3	46.0, 48.6
1 Weakness Definition	4,473,381	13.7	12.8, 14.5
2 Weakness Definitions	6,143,464	18.8	17.7, 19.8
3 Weakness Definitions	4,842,384	14.8	13.9, 15.6
<b>2010-2012 Waves (Females)</b>			
Any Weakness	19,249,136	48.4	47.0, 49.6
1 Weakness Definition	5,490,715	13.8	12.8, 14.7
2 Weakness Definitions	7,743,451	19.5	18.4, 20.4
3 Weakness Definitions	6,014,970	15.1	14.2, 15.9
<b>2014-2016 Waves (Females)</b>			
Any Weakness	22,636,923	54.5	53.1, 55.9
1 Weakness Definition	6,422,908	15.5	14.4, 16.5
2 Weakness Definitions	8,966,254	21.6	20.4, 22.7
3 Weakness Definitions	7,247,761	17.5	16.5, 18.4
<b>2006-2008 Waves (Males)</b>			
Any Weakness	11,663,553	42.4	40.8, 43.9
1 Weakness Definition	5,762,021	21.0	19.6, 22.2
2 Weakness Definitions	3,247,618	11.8	10.8, 12.7
3 Weakness Definitions	2,653,914	9.6	8.8, 10.4
<b>2010-2012 Waves (Males)</b>			
Any Weakness	15,459,031	44.6	43.1, 46.0
1 Weakness Definition	7,494,218	21.6	20.3, 22.8
2 Weakness Definitions	4,315,333	12.5	11.5, 13.3
3 Weakness Definitions	3,649,480	10.5	9.7, 11.3
<b>2014-2016 Waves (Males)</b>			
Any Weakness	18,183,911	50.4	48.7, 52.0
1 Weakness Definition	8,426,004	23.4	21.9, 24.7
2 Weakness Definitions	5,122,120	14.2	13.1, 15.2
3 Weakness Definitions	4,635,787	12.8	11.9, 13.8

## Conclusions

The findings from this investigation revealed that the estimated prevalence of weakness is pronounced in the United States.

Approximately 53% of Americans aged at least 50-years might be considered weak.

Physical activity participation and a healthy diet remain crucial for preventing, treating, and changing weakness status.

## Practical Applications

Continuing to surveil weakness status at individual and population-based levels may help to inform the effectiveness of current interventions aiming to improve strength during aging, guide programming related to strength capacity, and reveal populations that should be targeted for weakness interventions.

Handgrip dynamometers could be useful tools for feasibly assessing strength capacity in relevant aging populations.