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The association of objectively measured physical activity and sedentary behavior with skeletal muscle strength and muscle power in older adults: A systematic review and meta-analysis

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A R T I C L E I N F O

Keywords:
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Sedentary behavior
Accelerometry
Muscle strength
Muscle contraction
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A B S T R A C T

Background: Engaging in physical activity (PA) and avoiding sedentary behavior (SB) are important for healthy ageing with benefits including the mitigation of disability and mortality. Whether benefits extend to key determinants of disability and mortality, namely muscle strength and muscle power, is unclear.
Aims: This systematic review aimed to describe the association of objective measures of PA and SB with measures of skeletal muscle strength and muscle power in community-dwelling older adults.
Methods: Six databases were searched from their inception to June 21st, 2020 for articles reporting associations between objectively measured PA and SB and upper body or lower body muscle strength or muscle power in community dwelling adults aged 60 years and older. An overview of associations was visualized by effect direction heat maps, standardized effect sizes were estimated with albatross plots and summarized in box plots. Articles reporting adjusted standardized regression coefficients (β) were included in meta-analyses.
Results: A total of 112 articles were included representing 43,796 individuals (range: 21 to 3726 per article) with a mean or median age from 61.0 to 88.0 years (mean 56.4 % female). Higher PA measures and lower SB were associated with better upper body muscle strength (hand grip strength), upper body muscle power (arm curl), lower body muscle strength, and lower body muscle power (chair stand test). Median standardized effect sizes were consistently larger for measures of PA and SB with lower compared to upper body muscle strength and muscle power. The meta-analyses of adjusted β coefficients confirmed the associations between total PA (TPA), moderate-to-vigorous PA (MVPA) and light PA (LPA) with hand grip strength ($\beta = 0.041$, $\beta = 0.057$, and $\beta = 0.070$, respectively, all $p \leq 0.001$), and TPA and MVPA with chair stand test ($\beta = 0.199$ and $\beta = 0.211$, respectively, all $p \leq 0.001$).
Conclusions: Higher PA and lower SB are associated with greater skeletal muscle strength and muscle power, particularly with the chair stand test.

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1. Introduction

Low physical activity (PA) and high sedentary behavior (SB) present a global health challenge and they are particularly important in older adult populations as PA declines and SB increases with increasing age (Arnardottir et al., 2013; Ortlieb et al., 2014; Reid and Fielding, 2012). PA is defined as any bodily movement produced by skeletal muscle that requires energy expenditure (Caspersen et al., 1985), while SB is defined as periods of waking activity that produce little or no energy expenditure (Tremblay, 2012; Tremblay et al., 2017). Both PA and SB can be most accurately captured by objective devices such as accelerometers or pedometers, which can capture the incidental, unstructured, and light-intensity movement characterizing the majority of PA in older adults that can otherwise be subject to significant bias when self-reported (Amagasa et al., 2017; Lee and Shiroma, 2014; Lohne-Seiler et al., 2014). PA and SB are closely related but distinct behaviors (van der Ploeg and Hillsdon, 2017) that are each independent determinants of adverse outcomes such as morbidity, disability, poor quality of life, and mortality (Cunningham et al., 2020; Fornias et al., 2014; Rojer et al., 2020; Tak et al., 2013; Vagetti et al., 2014). The degree to which objectively measured habitual PA and SB are associated with other determinants of these adverse outcomes, namely skeletal muscle strength and muscle power (Katzmarzyk and Craig, 2002; Rantanen, 2003), has remained to be unexplored by a systematic review.

Skeletal muscle strength (the amount of force a muscle can produce with a single maximal effort) and muscle power (the ability to exert maximal force in a short time) (Beaudart et al., 2019) decline with chronological age (Beenakker et al., 2010; Chodzko-Zajko et al., 2009; Reid et al., 2014) and are not only functionally important (Wang et al., 2020) but are also key determinants of adverse outcomes such as morbidity, disability, poor quality of life, and mortality (Ling et al., 2010; Meskers et al., 2019; Taekema et al., 2010). Muscle strength and muscle power may therefore play a role in the relationship between PA/SB and adverse outcomes. Establishing and quantifying the association between PA and SB with muscle strength and muscle power is thus a priority for informing potential lifestyle guidelines, interventions and, ultimately, mitigating poor health outcomes.

The aim of this systematic review was to describe and quantify the associations of objectively measured PA and SB with muscle strength and muscle power in community-dwelling older adults.

2. Methods

2.1. Information sources and search

The protocol for this review was registered in the PROSPERO International prospective register of systematic review (registration number: CRD42018103910). PubMed, EMBASE, the Cochrane Library (via Wiley), CINAHL, PsycINFO, and SPORTDiscus (via EBSCO) were systematically searched according to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) statement (Moher et al., 2009) by two independent assessors (AR and RO) to identify articles published from inception to June 21st, 2020 investigating PA and SB in older adults. The full search strategy is presented in Appendix A and included the keywords: 'active or inactive lifestyle'; 'motor activity'; 'people over 60 years of age'. Articles investigating PA and SB in relation to muscle strength and muscle power were organized and managed using EndNote (Version X8.2 Clarivate Analytics, Philadelphia, USA) and Rayyan (Ouzzani et al., 2016).

2.2. Eligibility criteria

Articles were considered eligible using the following criteria: 1) English language original article in full text, 2) observational or experimental design, 3) mean or median age of the study population ≥60 years old, 4) study population consisting of community-dwelling individuals (exclusively institutionalized populations were excluded), 5) objective PA/SB measured with an instrument (accelerometer or pedometer), 6) skeletal muscle strength or muscle power reported, 7) the association of objective PA/SB measures and muscle strength/muscle power was reported, 8) associations were reported in control group or using baseline data of intervention studies.

2.3. Article selection

The title and abstract of articles were assessed by two independent reviewers (KR and EvdR), for potential eligibility. The subsequent full text screening was performed in duplicate by two independent reviewers (KR and LD or AR). Disagreement was resolved by an additional reviewer (AM). The references of all included articles as well as relevant systematic reviews (Cunningham et al., 2020; Mañas et al., 2017; Osthoff et al., 2013) were screened for additional articles.

2.4. Data extraction

Data were extracted in duplicate independently by two reviewers (KR and LD or AR): first author; year of publication; number of participants; study population characteristics; country(s); study design; follow-up period (if applicable); mean age; sex; accelerometer or pedometer device for objective assessment of PA/SB; wearing location of device; minimum wearing duration to constitute a valid day; number of valid days assessed; number of valid days required for inclusion in analysis; mean device wear time; measures used to assess PA/SB and their definitions; mean (standard deviation (SD)) or median [interquartile range (IQR)] capacity recorded as upper body or lower body and muscle strength or muscle power; measures used to assess muscle strength/muscle power and their definitions; mean (SD) or median [IQR] muscle strength/muscle power; analysis used to study association(s); adjustment model(s); effect size(s) and significance.

2.5. Study quality & risk of bias

Study quality and risk of bias of the included articles were independently assessed by two reviewers (KR and LD or AR) using the nine-point Newcastle-Ottawa Scale (NOS) adapted for cross-sectional studies and longitudinal studies as presented in Appendix B (Wells et al., 2000, 2012). Articles were assessed by the following domains: 1. selection (representativeness of cohort and ascertainment of exposure), 2. comparability (adjustments and statistical tests), 3. outcome (assessment of outcome measure). Additional outcome criteria assessed for longitudinal studies were duration of follow up period and adequacy of participant retention after follow-up period. High quality versus low quality of articles was defined as ≥ or < 4/7 stars for cross-sectional studies and ≥ or < 5/9 stars for longitudinal studies, respectively.

2.6. Statistical analysis and data visualization

Associations between measures of PA/SB and upper body muscle strength, upper body muscle power, lower body muscle strength and lower body muscle power were reported in tables and synthesized in the following ways in accordance with Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) (Liberati et al., 2009) and Synthesis Without Meta-Analysis (SWiM) guidelines (Campbell et al., 2020): 1. an overview of all associations was qualitatively visualized in effect direction heat maps (Thomson and Thomas, 2013), 2. albatross plots provided visualization and quantification of estimated effect sizes (Harrison et al., 2017), and 3. meta-analyses were performed to obtain a pooled estimate of exclusively adjusted associations. Main PA/SB measures and units were continuous steps (#/day), activity counts (#/day), and PA (total PA (TPA), moderate-to-vigorous PA (MVPA), and light PA (LPA)) and SB duration in (all units of time/day). Intensity-based accelerometer measures and PA and SB frequency and accumulation (bouts) were included in tables within Appendix C. If PA/SB measures were reported in different units or as categorical variables, these were used instead. When more than one statistical test was used, the following hierarchy was applied for reporting each association for all methods of synthesis: 1. adjusted linear regressions, 2. adjusted logistic regressions (for articles reporting ordinal determinants, p-trend was used and if not, p-values comparing relatively best versus worst categories of PA were used), 3. partial correlations, 4. unadjusted regression/Pearson's correlations 5. Spearman's or Biserial correlations 6. ANOVA or ANCOVA 7. Mann U-Whitney, t-test, or chi-squared. Isotemporal substitution models were not included. Data were reported based on the following order of adjustment models: 1. age and sex, 2. age and sex + additional factors, 3. age or sex + additional factors, 4. neither age nor sex, only other factors 5. unadjusted. The direction of effect was defined as positive when higher PA and lower SB were associated with better muscle strength or muscle power and negative when associations indicated worse muscle strength or muscle power. Positive and negative effect directions were represented by an upwards or downwards triangle in effect direction heat maps and points on the right side (positive effect) or left side (negative effect) of albatross plots. If p-values were not reported, they were calculated using the following methods: for linear regression analyses, the upper and lower limits of the 95 % confidence interval (CI) and regression coefficient were used to calculate the standard error (SE) [(upper limit of CI – lower limit of CI)/3.92], which was used to calculate the absolute value of the z-statistic (regression coefficient/SE), and finally the calculated p-value (p(calc))=exp (-0.717 (z) – (0.416 (z^2)) (Altman and Bland, 2011). For Pearson's, partial, Spearman's and point-biserial correlations, the sample size (n) and coefficients (Rs)

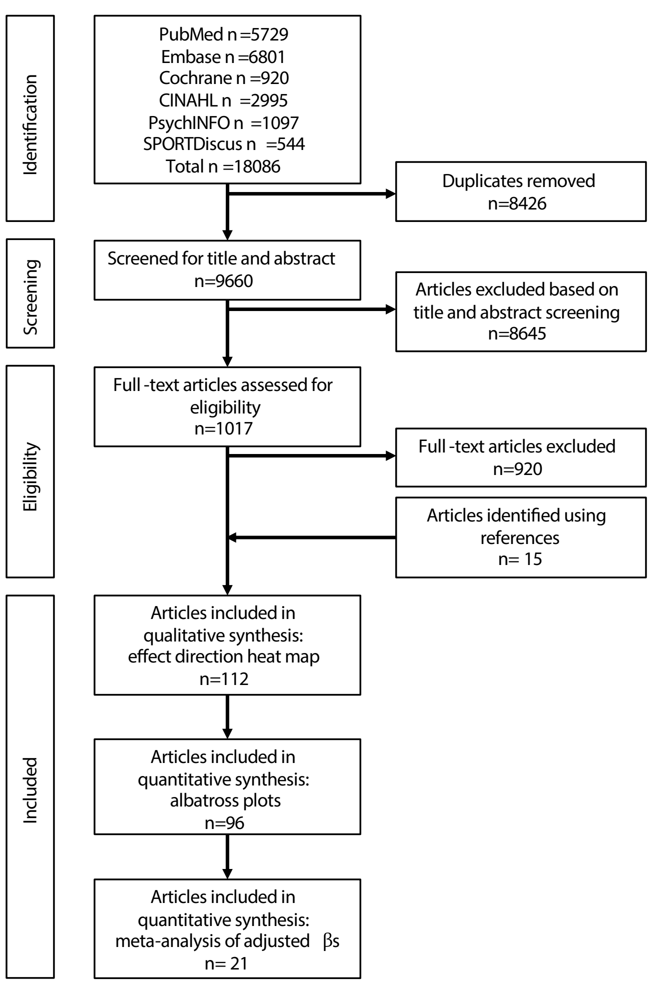

Fig. 1. Flowchart of the article selection process.

(including, Pearson's R, partial R, Spearman's Rho, and point-biserial R (Rpb)) were used to calculate the t-statistic using the following formula: t-statistic = $R\sqrt{[(n-2)/(1-R)]}$. The absolute value of the t-statistic and degrees freedom (n-2) were compared to the 2-tailed Student's t-distribution using Microsoft Excel to obtain the p-value. If R^2 was reported, the square root was calculated and treated as a correlation to calculate the p-value. P-values that were reported as $p > 0.05$ or $p < 0.05$ and could not be calculated using the above methods were conservatively estimated as $p \geq 0.25$ (when reported as non-significant) or $0.01 \leq p < 0.05$ (when reported as significant) to be included in the effect direction heat maps and were not included in albatross plots. The following color scheme was used in the effect direction heat maps: $p < 0.001$ (darkest blue filled triangle), $0.001 \leq p < 0.01$ (blue filled triangle), $0.01 \leq p < 0.05$ (light blue filled triangle), $0.05 \leq p < 0.1$(light grey empty triangle), $0.1 \leq p < 0.25$ (grey empty triangle), and $p \geq 0.25$ (dark grey empty triangle). Albatross plots were created using Stata Statistical Software: Release 16.0 (StataCorp LLC, College Station, Texas, United States) to assess the approximate magnitude of associations as a function of sample size against two-sided p-values stratified by the observed direction of the effect. Contour lines were superimposed on the plot to evaluate the hypothetical effect sizes, designated as standardized regression coefficients (βs) and were derived from the following equation: $N=(1-\beta^2/\beta^2)\ Z_p$ (where Z_p is the z value for the associated 2-sided p-value) (Harrison et al., 2017). Albatross plots were made for each association between PA/SB measures and outcomes if reported in at least five studies. Albatross plots were visually interpreted for scatter of β coefficients relative to three displayed contour lines and β coefficients were summarized in box plots that were made using Plotly (Plotly Technologies Inc., Montreal, Québec, Canada). Articles were included in the meta-analyses if the associations between PA or SB measures and hand grip strength or chair stand test were expressed as adjusted (order of adjustment models as given above) standardized regression coefficients (β) and their 95 % CI or SE or when these could be calculated. PA/SB measures for meta-analyses were grouped into total PA (TPA), moderate-to-vigorous PA (MVPA) duration, and light PA (LPA) duration. TPA included TPA duration, inverse SB duration, steps per day and number of breaks in sedentary behavior (BST). β coefficients were inversed for outcomes where a lower score indicated better performance. Adjusted unstandardized regression coefficients (B) were converted to β coefficients using the following formulas:

$$\boldsymbol{\beta} = \frac{SD_x}{SD_y}\ \boldsymbol{B} \textbf{ and SE } (\boldsymbol{\beta}) = \frac{SD_x}{SD_y}\ \textbf{SE}(\boldsymbol{B})$$

Where SD_x and SD_y are the standard deviations of PA (x) and hand grip strength or chair stand test (y), respectively (Nieminen et al., 2013). If SDs were not reported, they were calculated from the SE (or 95 % CI) using the following formula: SD= $\sqrt{n}$ (SE) (Cochrane Handb. Syst. Rev. Interv., 2019). If SE (B) was not reported, it was calculated from the 95 % CI of B using the previously mentioned formula. Correlation data from articles that did not perform a linear regression analysis, but reported all intercorrelations between PA/SB, hand grip strength or chair stand test, and age and/or sex Pearson's r (i.e. correlation matrices) and their calculated SE were used to calculate the age and/or sex adjusted β (SE β) using the following formulas:

$$\textbf{SE of correlations}: \textbf{SE}(\boldsymbol{r}) = \sqrt{\frac{1-r^2}{n-2}}$$

$$\textbf{One covariate model}:\ \boldsymbol{\beta}_{x_1.x_2} = \frac{r_{yx_1} - r_{yx_2} r_{x_1x_2}}{1 - r^2_{x_1x_2}} \textbf{ and SE } (\boldsymbol{\beta}_{x_1.x_2}) = \frac{SE(r_{yx_1}) - SE(r_{yx_2}) SE(r_{x_1x_2})}{1 - SE(r^2_{x_1x_2})}$$

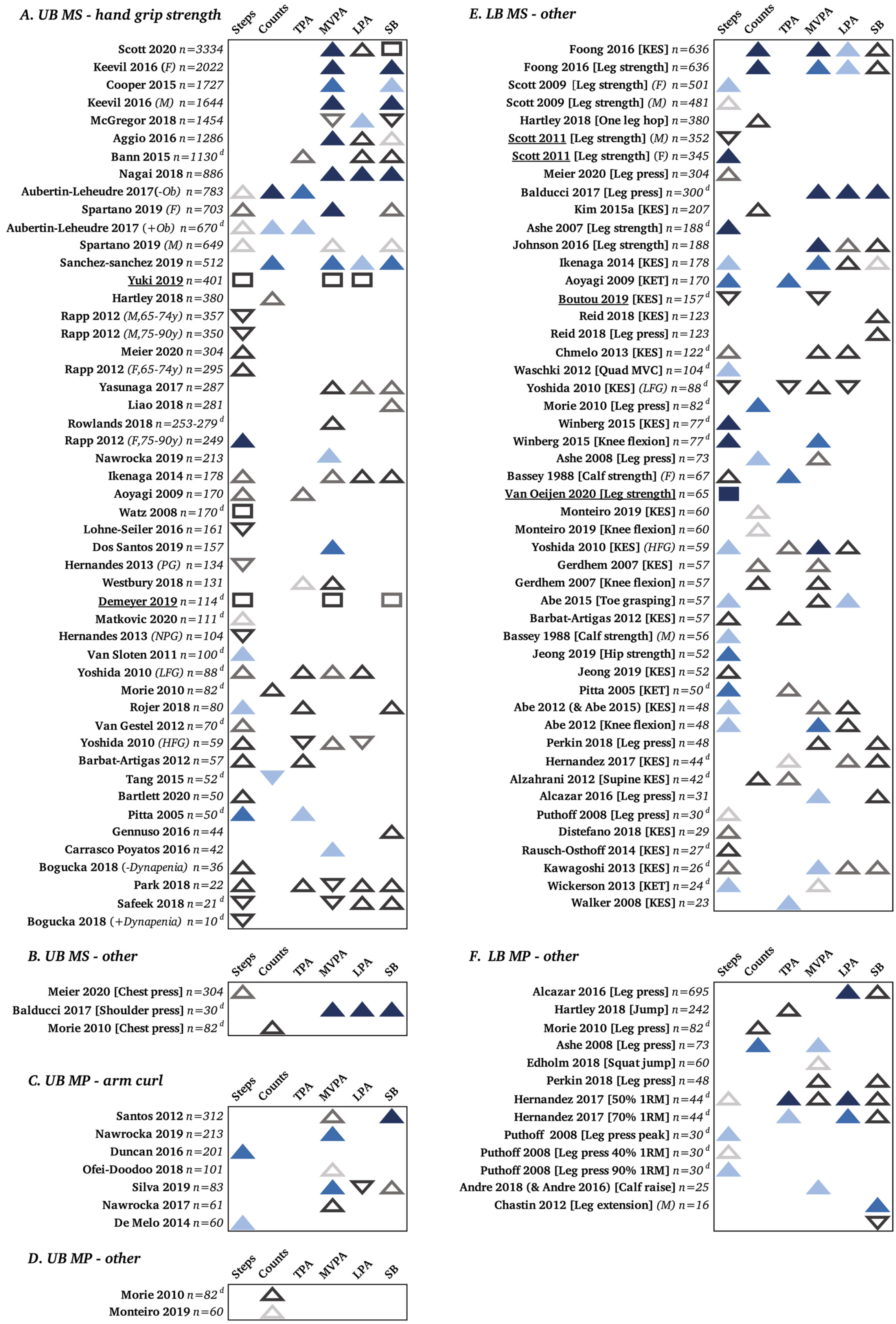

Fig. 2. Effect direction heat maps of the associations between physical activity and sedentary behavior with upper (A, B, C, D) and lower body (E, F, G) muscle strength and muscle power.

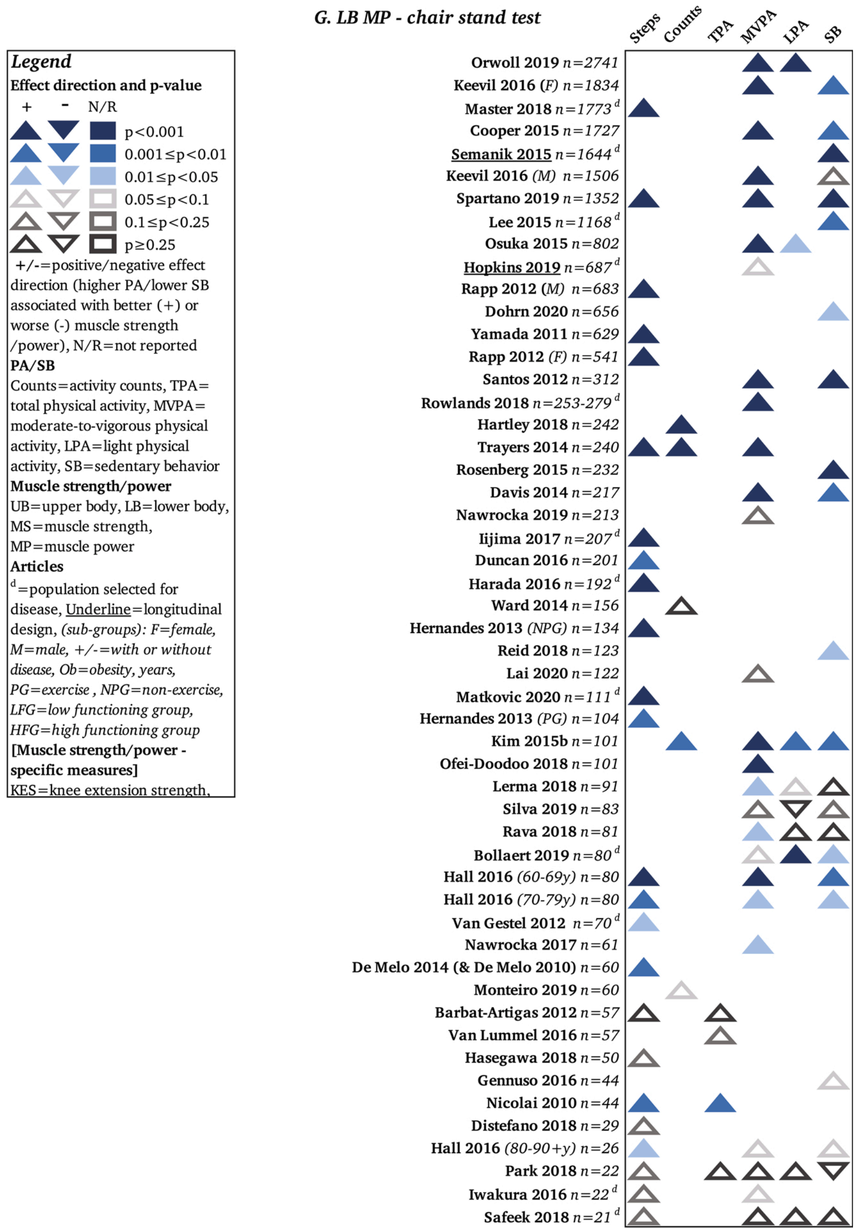

Fig. 2. (*continued*).

$$\textbf{Two covariate model:}\quad \beta_{x_1 \cdot x_2 x_3} = \frac{\left(1 - r^2_{x_2x_3}\right) r_{yx_1} + \left(r_{x_1x_3} r_{x_2x_3} - r_{x_1x_2}\right) r_{yx_2} + \left(r_{x_1x_2} r_{x_2x_3} - r_{x_1x_3}\right) r_{yx_3}}{1 - r^2_{x_1x_2} - r^2_{x_1x_3} - r^2_{x_2x_3} + 2 r_{x_1x_2} r_{x_1x_3} r_{x_2x_3}}$$

$$\textbf{and SE}\ (\beta_{x_1 \cdot x_2 x_3}) \frac{\left(1 - SE(r^2_{x_2x_3}\right) SE(r_{yx_1}) + \left(SE(r_{x_1x_3}) SE(r_{x_2x_3}) - SE(r_{x_1x_2})\right) r_{yx_2} + \left(SE(r_{x_1x_2}) SE(r_{x_2x_3}) - SE(r_{x_1x_3})\right) SE(r_{yx_3})}{1 - SE(r^2_{x_1x_2}) - SE(r^2_{x_1x_3}) - SE(r^2_{x_2x_3}) + 2 SE(r_{x_1x_2}) SE(r_{x_1x_3}) SE(r_{x_2x_3})}$$

Where r is Pearson's correlation coefficient, n is the sample size, x_1 is the PA/SB variable (independent variable), x_2 is age or sex in the one-covariate model and x_2 and x_3 are age and sex in the two-covariate model (independent variables being held constant for adjustment), and y is hand grip strength or chair stand test (dependent variable) (Cohen et al., 2003; Fernández-Castilla et al., 2019). All formulas and required data were entered manually and calculations were performed using Microsoft Excel (Version 16.16.22). A random-effects model was used due to heterogeneity between studies and results were visualized by forest plots. Heterogeneity was assessed using I^2 statistics; an I^2 value

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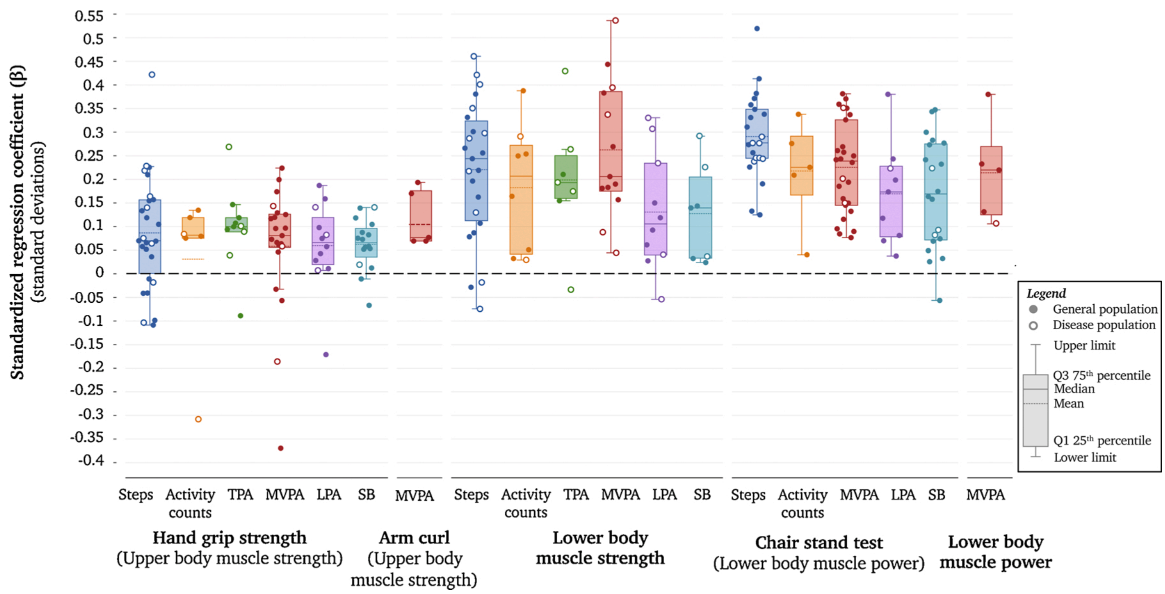


Fig. 3. Effect sizes of physical activity and sedentary behavior with muscle strength and muscle power derived from albatross plots, expressed as standardized regression coefficients (β).

above 25 % was considered as low, above 50 % as moderate and above 75 % as high heterogeneity. Funnel plots, depicting β coefficient against SE, were used for visual evaluation and Egger's regression test for statistical detection of publication bias ($p < 0.05$ indicating publication bias) (Egger et al., 1997). Meta-analyses were performed in Comprehensive Meta-Analysis (CMA) software (Biostat, Englewood, New Jersey, United States).

3. Results

3.1. Search results and study characteristics

A total of 18,086 articles were identified and 9,660 were left after removal of duplicates. Full texts were assessed of 1,017 articles and 112 articles were included (Fig. 1); all extracted data are provided in tables in Appendix C (Tables C1-C5), which are synthesized in Figs. 2-4 and in figures in Appendix D (Figs. D1-D8). Included articles represent a total of 43,796 individuals (range across articles: 21 to 3,726) with an average of 56.4 % female and the study populations' mean or median age ranged from 61.0–88.0 years. Sixty-two articles reported exclusively on community dwelling older adults or community-based samples from the general population. Other articles included community dwelling populations selected for specific disease (or health conditions) and included chronic obstructive pulmonary disorder (n = 14), osteoarthritis (n = 6), diabetes (n = 3), limited mobility (n = 3), any chronic disease (n = 1), HIV (n = 1), interstitial lung disease (n = 1), peripheral artery disease (n = 1), global cognitive impairment (n = 1), aortic stenosis (n = 1), stroke (n = 1), chronic idiopathic axonal polyneuropathy (n = 1), and polio (n = 1). All articles reported cross-sectional associations except for four reporting longitudinal associations (Demeyer et al., 2019; Scott et al., 2011; Semanik et al., 2015; Yuki et al., 2019) (Table C1). According to the NOS scale, 81 out of 112 articles were high quality (Table C2).

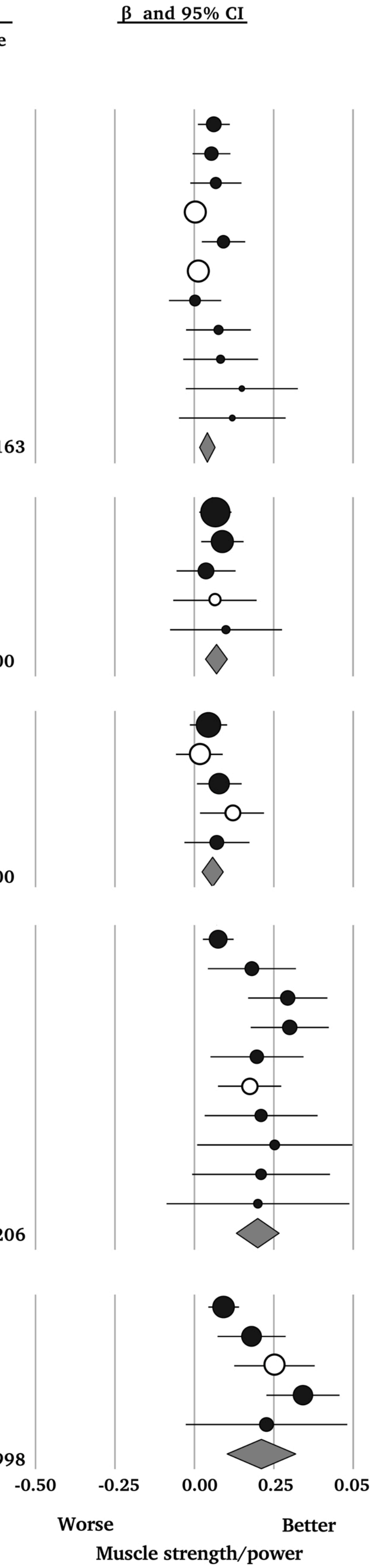
3.2. Measures of physical activity and sedentary behavior

PA and SB were measured by use of an accelerometer in 92 of articles, while in 20 articles a pedometer was used. PA was expressed as number of steps (or walking duration), number of activity counts, TPA duration (or standing + walking duration, time on feet, and non-sedentary time), MVPA duration (or vigorous PA and moderate PA duration, individually), and SB was expressed as SB duration (or lying, sitting, basal activity, and inactive time). Intensity-based accelerometer measures were number of vector magnitude units (VMU), total volume (metabolic equivalent tasks/hour), energy-expenditure (EE) (or physical activity level (PAL) (EE/sleeping metabolic rate)), and intensity gradient (intensity vs. time). Measures of PA and SB frequency and accumulation (bouts) were reported as number and duration of PA bouts, number of breaks in SB (BST), number of breaks per sedentary hour (SB break rate), number and duration of SB bouts, and number and duration of long SB bouts (Table C3).

3.3. Associations of PA and SB with muscle strength and muscle power

Table C4 describes muscle strength and muscle power measurement; Table C5 provides all associations, which are visualized by effect direction heat maps in Fig. 2, Figs. D1 and D2; Fig. 3 summarizes βs (median [IQR]) obtained from the albatross plots in Figure D3-D7; and meta-analyses of adjusted βs are presented in Fig. 4 with corresponding funnel plots in Figure D8.

Association	Author year	N	β	Upper limit	Lower limit	p-value	Relative weight
A. TPA and hand grip strength							
	Cooper 2015	1727	0.062	0.013	0.111	0.014	13.365
	Aggio 2016	1286	0.054	-0.004	0.113	0.068	11.133
	Dogra 2017	1157	0.068	-0.011	0.147	0.092	7.572
	Bann 2015 *(F)*	757[a]	0.000	-0.018	0.018	0.991	22.811
	Sanchez-sanchez 2019	512	0.092	0.025	0.159	0.007	9.468
	Bann 2015 *(M)*	373[a]	0.015	-0.005	0.036	0.148	21.994
	Meier 2020	304	0.003	-0.078	0.083	0.950	6.59
	Yasunaga 2017	287	0.077	-0.024	0.177	0.135	5.281
	Liao 2018	281	0.083	-0.033	0.199	0.163	4.143
	Westbury 2018	191	0.150	-0.025	0.325	0.093	2.018
	Rojer 2018	80	0.120	-0.046	0.286	0.157	2.214
			0.041	**0.017**	**0.065**	**0.001**	**I^2=52.163**
B. MVPA and hand grip strength							
	Cooper 2015	1727	0.067	0.017	0.116	0.008	47.894
	Sanchez-sanchez 2019	512	0.089	0.023	0.154	0.008	27.406
	Yasunaga 2017	287	0.037	-0.054	0.129	0.426	13.969
	Rowlands 2018	266	0.065	-0.065	0.195	0.327	6.919
	Westbury 2011	191	0.100	-0.075	0.275	0.263	3.812
			0.070	**0.036**	**0.104**	**0.000**	**I^2=0.000**
C. LPA and hand grip strength							
	Aggio 2016	1286	0.045	-0.013	0.102	0.128	33.656
	Bann 2015 *(F)*	757[a]	0.015	-0.057	0.088	0.678	21.111
	Sanchez-sanchez 2019	512	0.078	0.009	0.147	0.026	23.178
	Bann 2015 *(M)*	373[a]	0.118	0.019	0.218	0.019	11.201
	Yasunaga 2017	287	0.071	-0.030	0.172	0.168	10.854
			0.057	**0.024**	**0.090**	**0.001**	**I^2=0.000**
D. TPA and chair stand test							
	Cooper 2015	1727	0.075	0.028	0.122	0.002	18.606
	Sardinha 2015	512	0.181	0.044	0.318	0.010	11.697
	Santos 2012	312	0.294	0.171	0.417	0.000	12.714
	Rosenberg 2015	232	0.300	0.178	0.422	0.000	12.864
	Davis 2014	217	0.197	0.052	0.342	0.008	11.146
	Harada 2016	192	0.174	0.076	0.272	0.001	14.734
	Reid 2018	123	0.210	0.034	0.386	0.020	8.27
	Bollaert 2019	80	0.253	0.010	0.496	0.041	6.158
	Gennuso 2016	50	0.210	-0.006	0.426	0.056	7.228
	Hasegawa 2018	50	0.200	-0.086	0.486	0.171	4.854
			0.199	**0.132**	**0.266**	**0.000**	**I^2=61.206**
E. MVPA and chair stand test							
	Cooper 2015	1727	0.092	0.045	0.139	0.000	26.159
	Santos 2012	312	0.180	0.074	0.286	0.001	21.757
	Rowlands 2018	266[b]	0.252	0.127	0.377	0.000	20.055
	Ofei-Doodoo 2018	101	0.342	0.228	0.456	0.000	21.078
	Bollaert 2019	80	0.227	-0.026	0.480	0.078	10.941
			0.211	**0.103**	**0.319**	**0.000**	**I^2=79.998**



Legend
● general population ○ disease population
[a,b]sample size estimated, *M=male, F=female*

Fig. 4. Forest plots and meta-analysis of adjusted standardized regression coefficients (β) and 95 % CI of the associations between of physical activity measures with hand grip strength (A, B, C) and chair stand test (D, E), respectively.
[a]Bann 2015 reported approximate gender distribution and sample sizes were subsequently estimated for males and females from the total population, respectively.
[b]Rowlands 2018 reported determinant and outcome driven sample size as a range and the median was subsequently used as the estimate for sample size.

3.3.1. Upper body muscle strength

Hand grip strength was reported in 41 articles. Higher TPA (median [IQR], β = 0.100 [0.090-0.116]), MVPA (β = 0.081 [0.059-0.125]), activity counts (β = 0.082 [0.077-0.110]), LPA (β = 0.066 [0.024-0.109]), steps (β = 0.070 [-0.013-0.156]), and lower SB (β = 0.066 [0.044-0.092]) were associated with higher hand grip strength (Fig. 3 and Fig. D3). However, the association of steps and hand grip strength was inconsistent in direction of effect and significance (Fig. 2). Positive associations were confirmed in the pooled meta-analysis of adjusted βs for the associations of TPA and hand grip strength including 10 articles representing 6,995 individuals (β = 0.041, 95 % CI: 0.017-0.065, p = 0.001, $I^2 = 52.2$); MVPA and hand grip strength including four articles representing 2,983 individuals (β = 0.070, 95 % CI: 0.036-0.104, p = 0.000, $I^2 = 0.0$); and LPA and hand grip strength including four articles representing 3,215 individuals (β = 0.057, 95% CI: 0.024-0.090, p = 0.001, $I^2 = 0.0$) (Fig. 4). Intensity-based accelerometer measures of PA were inconsistently associated with hand grip strength (Fig. D1) and measures of PA and SB frequency and accumulation (bouts) were not associated with hand grip strength (Fig. D2). All PA/SB measures were associated with greater shoulder press strength; steps and activity counts were not associated with chest press strength (Fig. 2).

3.3.2. Upper body muscle power

The number of arm curls completed within 30 s was reported in nine articles. Associations between higher steps and lower SB with arm curl were positive and significant, while associations of MVPA with arm curl were positive (β = 0.077 [0.069-0.170]) but only significant in one out of four associations (Figs. 2 and 3). Activity counts were not associated with chest press power (Fig. 2).

3.3.3. Lower body muscle strength

Knee extension strength was reported in 24 articles, leg press strength in seven, leg strength in six, knee flexion strength in four, knee extension torque in three, hip strength in one, toe grasping strength in one, and calf strength in one. Higher steps (β = 0.244 [0.118-0.316]), MVPA (β = 0.206 [0.175-0.386]), TPA (β = 0.193 [0.160-0.250]), activity counts (β = 0.207 [0.046-0.263]), and LPA (β = 0.105 [0.040-0.234]) were associated with better lower body strength (Fig. 3 and Fig. D5). While the positive direction of effect of lower SB with better lower body muscle strength was consistent for all associations (β = 0.140 [0.033-0.205]), results were only statistically significant in one of nine associations (Fig. 2, Fig. 3, and Fig. D5). Intensity-based accelerometer measures, EE and VMU, were positively associated with lower body muscle strength, while MET was not (Fig. D1)

3.3.4. Lower body muscle power

Chair stand tests were reported in 51 articles. Higher PA and lower SB were consistently associated with better chair stand test performance (Fig. 2 and Fig. D1), with the exception of measures of PA and SB frequency and accumulation (Fig. D2). The largest effect size was identified for steps (β = 0.277 [0.254, 0.348]) with chair stand test and followed respectively by activity counts (β = 0.225 [0.167-0.291]), MVPA (β = 0.239 [0.145-0.326]), LPA (β = 0.173 [0.0078-0.228]), and SB (β = 0.169 [0.072-0.275]) (Fig. 3 and Fig. D6). Pooled adjusted βs of TPA and MVPA with chair stand test included ten articles representing 3,495individuals and five articles representing 2486 individuals, respectively and both TPA (β = 0.199, 95 % CI: 0.132-0.266, p = 0.000, $I^2 = 61.21$) and MVPA (β = 0.211, 95 % CI: 0.103-0.319, p = 0.000, $I^2 = 80.00$) were significantly associated with better chair stand test performance (Fig. 3). Leg press power at varying percentages of an individual's 1RM and/or peak power was reported in five articles, and leg extensor power (Nottingham Power Rig), jumping power, the calf raise test (# of calf raises/30 s), and the squat jump test were each reported in one article. Associations between PA and SB with these lower body muscle power measures were not consistently significant (Fig. 2, Fig. D1, Fig. D2). The median magnitude of effect for MVPA and lower body muscle power (β = 0.220 [0.125-0.269]) was consistent with that of chair stand test (Fig. 3 and Fig. D7).

3.3.5. Longitudinal associations

Seven articles reported longitudinal associations. Neither baseline nor change in PA was associated with changes with hand grip strength in two articles: non-significant associations were found between steps, MVPA, and SB, and change in steps with change in hand grip strength after 2.6 years in a COPD population (Demeyer et al., 2019) and non-significant associations were found between steps, LPA, and MVPA with development of low hand grip strength after 4.2 years in a community dwelling population (Yuki et al., 2019). Bidirectional positive associations of PA and lower body muscle strength were identified in three articles: a highly significant association was found between steps and change in leg strength over 2.6 years in females (B = 1.06, 95 % CI: 0.31, 1.31) but not males (B=-0.28, 95 % CI: -1.27, 0.72) in a general population (Scott et al., 2011); a highly significant association was found between change in lower extremity strength after 4 years and the course of change in steps over four different time points spanning a total follow-up of 4 years (B=-1782, 95 % CI: -3348, -217) in a population with chronic idiopathic axonal polyneuropathy (van Oeijen et al., 2020); KES was associated with change after 1 year in MET and VMU (B=-0.001 (SE = 6.00E-4) and B=-0.005 (SE = 0.002), respectively), but not with steps or MVPA in a COPD population (Boutou et al., 2019). Two articles, including participants from the Osteoarthritis Initiative, showed a highly significant association between SB and change in chair stand test after 2 years (B=-0.58, 95 % CI: -0.92, -0.24) (Semanik et al., 2015) in 1, 659 participants but not for meeting guidelines for MVPA and change in chair stand test after 4 years 687 participants (Hopkins, 2019).

3.3.6. Influence of population

Stratification of the associations of PA/SB and muscle strength and muscle power by population showed similar distributions of effect directions, p-values, and β coefficients (Figs. 2-4 and Figure D1-D7).

3.3.7. Publication bias in meta-analyses

Funnel plots were visually evaluated and did not show asymmetry, indicating no evidence for the presence of publication bias in meta-analyses, except for a positive skew in the meta-analysis of TPA and hand grip strength. Egger's regression tests confirmed that no evidence for publication bias (all p > 0.05) was present, except of the TPA and hand grip strength meta-analysis (p = 0.000) (Fig. D8).

4. Discussion

This systematic review highlights the association between higher PA and lower SB with greater skeletal muscle strength and muscle power. Specifically, strongest associations were with lower body muscle strength and muscle power, and evidence was most consistent for the performance of the chair stand test. The associations were independent of the population studied. Meta-analyses of adjusted associations confirmed these results for hand grip strength and chair stand test. Longitudinal findings indicated bidirectional associations between PA and SB with lower body muscle strength and SB with chair stand test, but, contrastingly, a lack thereof with hand grip strength. These findings were in line with cross-sectional results, which identified larger effect sizes and more frequently significant associations for lower body muscle strength and muscle power than hand grip strength.

Higher PA and lower SB, using various objective measures, were associated with greater muscle strength and muscle power. MVPA was the most often reported measure and often positively associated with muscle strength and muscle power, which was an anticipated finding as MVPA is a strong determinant and predictor of health outcomes (Adelnia et al., 2019; Hupin et al., 2015; Menai et al., 2017). The positive association of activity counts with muscle strength and muscle power is in accordance with our findings for MVPA, as higher activity counts reflect higher intensity. Additional positive associations identified for LPA and negative associations for SB with muscle strength and muscle power are important in light of the substantial amount of time older adults spend in these two behaviors (Amagasa et al., 2017; Arnardottir et al., 2017; Harvey et al., 2015). However, the relatively strongest effect sizes for all outcomes were with steps and TPA, suggesting that all levels of physical activity can contribute to the positive associations with muscle strength and muscle power.

Evidence for the association of higher PA and lower SB with greater hand grip strength was present for all measures, except for PA and SB bout measures, and was most consistent for MVPA and activity counts. Hand grip strength is the most often used measure of muscle strength in clinical practice because of its practical advantages and clinical relevance (Beaudart et al., 2019; Reijnierse et al., 2017) and was also the most often reported measure in this review. Clear positive associations of MVPA and activity counts with hand grip strength can likely be explained by the incorporation for upper body muscle strength in high intensity PA. However, previous studies have cautioned the use of hand grip strength as a proxy for overall muscle strength and highlighted the need for lower body muscle strength measures (e.g. knee extension strength) as part of geriatric assessments (Yeung et al., 2018), which is in accordance with the present findings.

PA and SB were most associated with lower body muscle strength and muscle power measures, particularly, the performance of the chair stand test, which is a highly relevant finding given lower body muscle power, compared to muscle strength, is more important for activities of daily living (Foldvari et al., 2000; Wang et al., 2020) and thus the ability to remain living independently (Luppa et al., 2010; Mlinac and Feng, 2016). Muscle power is most affected by ageing with an annual decline of approximately 3 % compared to muscle strength and muscle mass with annual decline of approximately 2 % and 1 %, respectively (Reid et al., 2014). Furthermore, lower body muscle strength and muscle power decline faster during ageing compared to upper body measures (Hughes et al., 2001). This supports our longitudinal findings that, bidirectionally, PA and SB are associated with lower body muscle strength. However, we identified inconsistent longitudinal results for chair stand test: in 1,659 participants from the Osteoarthritis Initiative, there was a highly significant association between SB and change in chair stand test over 2 years which persisted after additional adjustment for MVPA (Semanik et al., 2015); on the other hand, in 687 participants from the same cohort, meeting MVPA guidelines was not associated with better chair stand test at 4 years follow-up (Hopkins, 2019). While there were substantial differences in loss to follow up in these two articles (13 % vs. 64 %, respectively), results may reiterate the distinction between PA and SB and indicate that, independent of MVPA, sedentary behavior is a stronger determinant of future muscle power than MVPA. This is an important finding given the increasing evidence of the distinct and deleterious effects of SB on future health status. This highlights the importance to design interventions to prevent or slow the decline in lower body muscle strength and power over time with consideration of differences between PA and SB.

Increasing habitual PA has well-established benefits to health (Bravata et al., 2007; Füzéki et al., 2017; Haider et al., 2019). However, inconclusive results on the ability of exercise interventions (structured PA) to improve muscle strength or muscle power have been reported (Clemson et al., 2012; Haider et al., 2019; Liu et al., 2014). Interventions to increase habitual PA in older adults typically include aerobic, balance and strength components. When these multicomponent interventions include resistance exercises, greater increases in muscle strength and muscle power are found (Ferreira et al., 2012; Liu et al., 2014). This is in line with the evidence that progressive resistance exercise training is very effective at increasing muscle strength and muscle power in older adults (Chodzko-Zajko et al., 2009; Guizelini et al., 2018; Straight et al., 2016). However, integrating exercise into lifestyle post-intervention remains a challenge and, subsequently, improvements in PA are often not sustained (McEwan et al., 2020; Sansano-Nadal et al., 2019). Behavioral change interventions that are complimentary to PA and SB behaviors in daily life, including strength activities such as squatting, lunging and wall sitting, may be more suitable than structured exercise interventions for long-term and sustainable increases in PA and maintenance of muscle strength and muscle power. These behavioral change interventions have been proven feasible in middle aged individuals (Schwenk et al., 2019; Taraldsen et al., 2019) and effective in improving PA, muscle strength, and reducing the number of falls in older individuals (Clemson et al., 2012, 2010).

4.1. Strengths and limitations

To the best of our knowledge, this is the first systematic review summarizing the associations between objective measures of PA and SB with skeletal muscle strength and muscle power in older adults. The primary strength of this review is the broad array of PA, SB, muscle strength and muscle power measures included which led to a high number of articles included. The use of exclusively objective measures of PA and SB represents a strength of this review as questionnaires may not capture unstructured PA or LPA (i.e. shuffling) (Amagasa et al., 2017; Manns et al., 2012) and older adults are susceptible to over-report PA and under-report SB (Colbert et al., 2011; Dyrstad et al., 2014; Van Cauwenberg et al., 2014). However, it is important to acknowledge that objective measures of PA and SB are limited in their capacity to measure the mode or type of PA or SB including resistance loading during activities, which presents a limitation. Furthermore, the inclusion of diverse and disease populations strengthens the generalizability of our results, but a limitation was our inclusion of only English-language articles. We identified considerable heterogeneity in study design, measures of PA/SB and muscle strength and muscle power and their definitions and statistical analyses used to present the associations. This posed methodological challenges to comparing and synthesizing our results. Nonetheless, we were able to show standardized effect estimates in albatross plots for all associations. This also enhanced the synthesis by avoiding reliance on p-values which are heavily driven by sample size regardless of the magnitude of true underlying effects (Sullivan and Feinn, 2012). Furthermore, we performed a meta-analysis for included articles reporting adjusted standardized regression data that confirmed our overall results.

4.2. Implications

There is both a clinical and public health urgency to identify the degree to which PA and SB can affect health (Taylor, 2014). Given the consequences of low muscle strength and muscle power including increased risk of falls, disability, and mortality and the subsequent public health burden of their high prevalence worldwide (Borges et al., 2020; Manini and Clark, 2012; Mitchell et al., 2012), the current study has significant implications for policy making. This systematic review quantifies the relative impact of higher duration, intensity, and frequency of PA and lower SB on muscle strength and muscle power, and thus provides a foundation to inform interventions; absolute quantification is a priority for future lifestyle guidelines and the management of modifiable risk factors.

5. Conclusion

Higher PA and lower SB are associated with greater skeletal muscle strength and muscle power in older adults, particularly with the chair stand test. Future research should investigate habitual resistance exercise components, while increasing PA and decreasing SB, and seek to identify specific thresholds as actionable targets to maintain and improve skeletal muscle strength and muscle power.

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Declaration of Competing Interest

The authors report no declarations of interest.

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Appendix A. Full search strategy (June 21, 2020)

PubMed

#	Query	Results
#14	#10 AND #13	**5.729**
#13	#11 OR #12	**2.085.084**
#12	"Motor Activity"[Mesh:NoExp] OR "Exercise"[Mesh] OR "Sports"[Mesh] OR "Physical Exertion"[Mesh] OR "Early Ambulation"[Mesh] OR "Exercise Therapy"[Mesh] OR "Exercise Movement Techniques"[Mesh] OR "Locomotion"[Mesh] OR "Motor Activit*"[tiab] OR "Physical Activit*"[tiab] OR "Locomotor Activit*"[tiab] OR "Exercis*"[tiab] OR "Physical Exercis*"[tiab] OR "Isometric Exercis*"[tiab] OR "Aerobic Exercis*"[tiab] OR "training"[tiab] OR "stretching"[tiab] OR "Physical Condition*"[tiab] OR "Physical fitness"[tiab] OR "Physical endurance"[tiab] OR "movement therap*"[tiab] OR "fitness training"[tiab] OR "Plyometric"[tiab] OR "Stretch-Shortening"[tiab] OR "Weight-Lifting"[tiab] OR "Weight-Bearing"[tiab] OR "running"[tiab] OR "jogging"[tiab] OR "walk*"[tiab] OR "bicycle"[tiab] OR "cycle"[tiab] OR "bicycling"[tiab] OR "cycling"[tiab] OR "rowing"[tiab] OR "swim*"[tiab] OR "ambulation"[tiab] OR "mobil*"[tiab] OR "pilates"[tiab] OR "yoga"[tiab]	**2.061.636**
#11	"Sedentary Behavior"[Mesh] OR "sedent*"[tiab] OR "sitting"[tiab] OR "physical inactivit*"[tiab]	**61.174**
#10	#3 OR #5 OR #9	**10.790**
#9	#1 AND #8	**4.320**
#8	#6 AND #7	**19.226**
#7	"Monitoring, Physiologic"[Mesh:NoExp] OR "Monitoring, Ambulatory"[Mesh:NoExp] OR "monitoring"[tiab]	**528.186**
#6	"Heart Rate"[Mesh:NoExp] OR "cardiac rate*"[tiab] OR "heart rate*"[tiab] OR "pulse rate*"[tiab] OR "cardiac frequency"[tiab] OR "heart frequency"[tiab]	**246.877**
#5	#1 AND #4	**868**
#4	"pedomet*"[tiab]	**2.755**
#3	#1 AND #2	**5.977**
#2	"Accelerometry"[Mesh] OR "Acceleromet*"[tiab] OR "actigra*"[tiab]	**23.701**
#1		**3.334.172**

(*continued on next page*)

(*continued*)

#	Query	Results
	("Aged"[Mesh] OR "Aged, 80 and over"[Mesh] OR "Frail Elderly"[Mesh] OR "Geriatrics"[Mesh] OR "Geriatric Psychiatry"[Mesh] OR "Geriatric Nursing"[Mesh] OR "Geriatric Dentistry"[Mesh] OR "Dental Care for Aged"[Mesh] OR "Health Services for the Aged"[Mesh]) OR ("elder*"[tw] OR "eldest"[tw] OR "frail*"[tw] OR "geriatri*"[tw] OR "old age*"[tw] OR "oldest old*"[tw] OR "senior*"[tw] OR "senium"[tw] OR "very old*"[tw] OR "septuagenarian*"[tw] OR "octagenarian*"[tw] OR "octogenarian*"[tw] OR "nonagenarian*"[tw] OR "centarian*"[tw] OR "centenarian*"[tw] OR "supercentenarian*"[tw] OR "older people"[tw] OR "older subject*"[tw] OR "older patient*"[tw] OR "older age*"[tw] OR "older adult*"[tw] OR "older man"[tw] OR "older men"[tw] OR "older male"[tw] OR "older woman"[tw] OR "older women"[tw] OR "older female"[tw] OR "older population*"[tw] OR "older person*"[tw])	

Embase.com

#	Query	Results
#15	#10 AND #14	**6.801**
#14	#11 OR #12 OR #13	**2.695.910**
#13	((motor NEXT/1 activit*):ab,ti,kw) OR ((physical NEXT/1 activit*):ab,ti,kw) OR locomot*:ab,ti,kw OR exercis*:ab,ti,kw OR training:ab,ti,kw OR stretching:ab,ti,kw OR ((physical NEXT/1 condition*):ab,ti,kw) OR 'physical fitness':ab,ti,kw OR 'physical endurance':ab,ti,kw OR ((movement NEXT/1 therap*):ab,ti,kw) OR plyometric:ab,ti,kw OR 'stretch shortening':ab,ti,kw OR 'weight lifting':ab,ti,kw OR 'weight bearing':ab,ti,kw OR running:ab,ti,kw OR jogging:ab,ti,kw OR walk*:ab,ti,kw OR bicycle:ab,ti,kw OR cycle:ab,ti,kw OR bicycling:ab,ti,kw OR cycling:ab,ti,kw OR rowing:ab,ti,kw OR swim*:ab,ti,kw OR ambulation:ab,ti,kw OR mobil*:ab,ti,kw OR pilates:ab,ti,kw OR yoga:ab,ti,kw	**2.314.193**
#12	'motor activity'/de OR 'exercise'/exp OR 'sport'/exp OR 'mobilization'/exp OR 'kinesiotherapy'/exp OR 'physical activity'/exp OR 'fitness'/exp OR 'locomotion'/exp	**951.571**
#11	'sedentary lifestyle'/exp OR 'sitting'/exp OR 'physical inactivity'/exp OR sedent*:ab,ti,kw OR sitting:ab,ti,kw OR ((physical NEXT/1 inactivit*):ab,ti,kw)	**91.488**
#10	#3 OR #5 OR #9	**12.541**
#9	#1 AND #8	**4.407**
#8	#6 AND #7	**25.596**
#7	'physiologic monitoring'/exp OR 'ambulatory monitoring'/exp OR monitoring:ab,ti,kw	**709.204**
#6	'heart rate'/de OR 'heart rate variability'/de OR 'resting heart rate'/de OR 'cardiac rate':ab,ti,kw OR 'heart rate':ab,ti,kw OR 'pulse rate':ab,ti,kw OR 'cardiac frequency':ab,ti,kw OR 'heart frequency':ab,ti,kw	**318.213**
#5	#1 AND #4	**1.097**
#4	'pedometer'/exp OR 'pedometry'/exp OR pedomet*:ab,ti,kw	**4.154**
#3	#1 AND #2	**7.844**
#2	'accelerometry'/exp OR 'accelerometer'/exp OR 'actimetry'/exp OR 'actigraph'/exp OR acceleromet*:ab,ti OR actigra*:ab,ti	**36.929**
#1	'aged'/exp OR 'geriatrics'/exp OR 'elderly care'/exp OR elder*:de,ab,ti OR eldest:de,ab,ti OR frail*:de,ab,ti OR geriatri*:de,ab,ti OR ((old NEXT/1 age*):de,ab,ti) OR ((oldest NEXT/1 old*):de,ab,ti) OR senior*:de,ab,ti OR senium:de,ab,ti OR ((very NEXT/1 old*):de,ab,ti) OR septuagenarian*:de,ab,ti OR octagenarian*:de,ab,ti OR octogenarian*:de,ab,ti OR nonagenarian*:de,ab,ti OR centarian*:de,ab,ti OR centenarian*:de,ab,ti OR supercentenarian*:de,ab,ti OR 'older people':de,ab,ti OR ((older NEXT/1 subject*):de,ab,ti) OR ((older NEXT/1 patient*):de,ab,ti) OR ((older NEXT/1 age*):de,ab,ti) OR ((older NEXT/1 adult*):de,ab,ti) OR 'older man':de,ab,ti OR 'older men':de,ab,ti OR 'older male':de,ab,ti OR 'older woman':de,ab,ti OR 'older women':de,ab,ti OR 'older female':de,ab,ti OR ((older NEXT/1 population*):de,ab,ti) OR ((older NEXT/1 person*):de,ab,ti)	**3.432.221**

The Cochrane Library (via Wiley)

#	Query	Results
#14	#10 and #13	**920**
#13	#11 or #12	**238.188**
#12	((motor NEXT activit*) or (physical NEXT activit*) or locomot* or exercis* or training or stretching or (physical NEXT condition*) or (physical NEXT fitness) or (physical NEXT endurance) or (movement NEXT therap*) or plyometric or (stretch NEXT shortening) or (weight NEXT lifting) or (weight NEXT bearing) or running or jogging or walk* or bicycle or cycle or bicycling or cycling or rowing or swim* or ambulation or mobil* or pilates or yoga):ti,ab,kw	**233.754**
#11	(Sedent* or sitting or (physical NEXT inactivit*)):ti,ab,kw	**14.465**
#10	#3 or #5 or #9	**1.334**
#9	#1 and #8	**406**
#8	#6 and #7	**6.983**
#7	monitoring:ti,ab,kw	**59.019**
#6	((cardiac NEXT rate):ab,ti,kw or (heart NEXT rate):ab,ti,kw or (pulse NEXT rate):ab,ti,kw or (cardiac NEXT frequency):ab,ti,kw or (heart NEXT frequency)):ti,ab,kw	**59.143**
#5	#1 and #4	**247**
#4	pedomet*:ti,ab,kw	**1.712**
#3	#1 and #2	**780**
#2	(acceleromet* or actigra*):ti,ab,kw	**5.965**
#1	(elder* or eldest or frail* or geriatri* or (old NEXT age*) or (oldest NEXT old*) or senior* or senium or (very NEXT old*) or septuagenarian* or octagenarian* or octogenarian* or nonagenarian* or centarian* or centenarian* or supercentenarian* or (older NEXT people) or (older NEXT subject*) or (older NEXT patient*) or (older NEXT age*) or (older NEXT adult*) or (older NEXT man) or (older NEXT men) or (older NEXT male) or (older NEXT woman) or (older NEXT women) or (older NEXT female) or (older NEXT population*) or (older NEXT person*)):ti,ab,kw	**76.361**

CINAHL (via EBSCO)

#	Query	Results
S14	S10 AND S13	2,995
S13	S11 OR S12	**592,088**
S12	((MH "Motor Activity") OR (MH "Exercise+") OR (MH "Sports+") OR (MH "Early Ambulation") OR (MH "Therapeutic Exercise+") OR (MH "Locomotion+")) OR TI ((“motor activit*” OR “physical activit*” OR locomot* OR exercis* OR training OR stretching OR “physical condition*” OR “physical fitness” OR “physical endurance” OR “movement therap*” OR plyometric OR “stretch shortening” OR “weight lifting” OR “weight bearing” OR running OR jogging OR walk* OR bicycle OR cycle OR bicycling OR cycling OR rowing OR swim* OR ambulation OR mobil* OR pilates OR yoga)) OR AB ((“motor activit*” OR “physical activit*” OR locomot* OR exercis* OR training OR stretching OR “physical condition*” OR “physical fitness” OR “physical endurance” OR “movement therap*” OR plyometric OR “stretch shortening” OR “weight lifting” OR “weight bearing” OR running OR jogging OR walk* OR bicycle OR cycle OR bicycling OR cycling OR rowing OR swim* OR ambulation OR mobil* OR pilates OR yoga))	**582,203**
S11	((MH "Life Style, Sedentary") OR (MH "Sitting")) OR TI ((sedent* OR sitting OR "physical inactivit*")) OR AB ((sedent* OR sitting OR "physical inactivit*"))	**26,571**
S10	S3 OR S5 OR S9	4,531
S9	S1 AND S8	1,003
S8	S6 AND S7	4,480
S7	(MH "Monitoring, Physiologic") OR TI monitoring OR AB monitoring	**111,399**
S6	(MH "Heart Rate") OR TI (("cardiac rate" or "heart rate" or "pulse rate" or "cardiac frequency" or "heart frequency")) OR AB (("cardiac rate" or "heart rate" or "pulse rate" or "cardiac frequency" or "heart frequency"))	**47,141**
S5	S1 AND S4	**643**
S4	(MH "Pedometers") OR TI pedomet* OR AB pedomet*	2,279
S3	S1 AND S2	3,047
S2	((MH "Accelerometry+") OR (MH "Accelerometers") OR (MH "Actigraphy")) OR TI ((acceleromet* or actigra*)) OR AB ((acceleromet* or actigra*))	**11,526**
S1	MH "Aged+" OR MH "Aged, 80 and Over" OR MH "Frail Elderly" OR MH "Geriatrics" OR MH "Geriatric Psychiatry" OR MH "Gerontologic Nursing+" OR MH "Gerontologic Care" OR MH "Health Services for the Aged" OR TI (elder* OR eldest OR frail* OR geriatri* OR “old age*” OR “oldest old*” OR senior* OR senium OR “very old*” OR septuagenarian* OR octagenarian* OR octogenarian* OR nonagenarian* OR centarian* OR centenarian* OR supercentenarian* OR “older people” OR “older subject*” OR “older patient*” OR “older age*” OR “older adult*” OR “older man” OR “older men” OR “older male” OR “older woman” OR “older women” OR “older female” OR “older population*” OR “older person*”) OR AB (elder* OR eldest OR frail* OR geriatri* OR “old age*” OR “oldest old*” OR senior* OR senium OR “very old*” OR septuagenarian* OR octagenarian* OR octogenarian* OR nonagenarian* OR centarian* OR centenarian* OR supercentenarian* OR “older people” OR “older subject*” OR “older patient*” OR “older age*” OR “older adult*” OR “older man” OR “older men” OR “older male” OR “older woman” OR “older women” OR “older female” OR “older population*” OR “older person*”)	**919,735**

APA PsychINFO (via EBSCO)

#	Query	Results
S17	S13 AND S16	**1,097**
S16	S14 OR S15	**527,097**
S15	(DE "Physical Activity" OR (DE "Exercise" OR DE "Aerobic Exercise" OR DE "Weightlifting" OR DE "Yoga") OR DE "Physical Fitness" OR (DE "Sports" OR DE "Baseball" OR DE "Basketball" OR DE "Football" OR DE "Judo" OR DE "Martial Arts" OR DE "Soccer" OR DE "Swimming" OR DE "Tennis" OR DE "Weightlifting") OR DE "Locomotion" AND #DE "Training" OR DE "Athletic Training" OR DE "Locomotion") OR TI ((“motor activit*” OR “physical activit*” OR locomot* OR exercis* OR training OR stretching OR “physical condition*” OR “physical fitness” OR “physical endurance” OR “movement therap*” OR plyometric OR “stretch shortening” OR “weight lifting” OR “weight bearing” OR running OR jogging OR walk* OR bicycle OR cycle OR bicycling OR cycling OR rowing OR swim* OR ambulation OR mobil* OR pilates OR yoga)) OR AB ((“motor activit*” OR “physical activit*” OR locomot* OR exercis* OR training OR stretching OR “physical condition*” OR “physical fitness” OR “physical endurance” OR “movement therap*” OR plyometric OR “stretch shortening” OR “weight lifting” OR “weight bearing” OR running OR jogging OR walk* OR bicycle OR cycle OR bicycling OR cycling OR rowing OR swim* OR ambulation OR mobil* OR pilates OR yoga))	**522,065**
S14	TI (sedent* OR sitting OR "physical inactivit*") OR AB (sedent* OR sitting OR "physical inactivit*")	**13,285**
S13	S6 OR S8 OR S12	1,802
S12	S4 AND S11	**131**
S11	S9 AND S10	1,175
S10	DE "Monitoring" OR TI monitoring OR AB monitoring	**58,460**
S9	DE "Heart Rate" OR TI ("cardiac rate" or "heart rate" or "pulse rate" or "cardiac frequency" or "heart frequency") OR AB ("cardiac rate" or "heart rate" or "pulse rate" or "cardiac frequency" or "heart frequency")	**28,295**
S8	S4 AND S7	**246**
S7	TI pedomet* OR AB pedomet*	**860**
S6	S4 AND S5	1,478
S5	(DE "Actigraphy") OR TI (acceleromet* OR actigra*) OR AB (acceleromet* OR actigra*)	6,322
S4	S1 OR S2 OR S3	**401,336**
S3	TI (elder* OR eldest OR frail* OR geriatri* OR “old age*” OR “oldest old*” OR senior* OR senium OR “very old*” OR septuagenarian* OR octagenarian* OR octogenarian* OR nonagenarian* OR centarian* OR centenarian* OR supercentenarian* OR “older people” OR “older subject*” OR “older patient*” OR “older age*” OR “older adult*” OR “older man” OR “older men” OR “older male” OR “older woman” OR “older women” OR “older female” OR “older population*” OR “older person*”) OR AB (elder* OR eldest OR frail* OR geriatri* OR “old age*” OR “oldest old*” OR senior* OR senium OR “very old*” OR septuagenarian* OR octagenarian* OR octogenarian* OR nonagenarian* OR centarian* OR centenarian* OR supercentenarian* OR “older people” OR “older subject*” OR “older patient*” OR “older age*” OR “older adult*” OR “older man” OR “older men” OR “older male” OR “older woman” OR “older women” OR “older female” OR “older population*” OR “older person*”)	**174,582**
S2	DE "Geriatrics"	**12,654**
S1	Limiters - Age Groups: Aged (65 yrs & older)	**325,601**

SPORTDiscus (via EBSCO)

#	Query	Results
S16	S12 AND S15	**544**
S15	S13 OR S14	**513,139**
S14	DE "PHYSICAL activity" OR (DE "EXERCISE" OR DE "ABDOMINAL exercises" OR DE "AEROBIC exercises" OR DE "ANAEROBIC exercises" OR DE "AQUATIC exercises" OR DE "ARM exercises" OR DE "BACK exercises" OR DE "BREATHING exercises" OR DE "BREEMA" OR DE "BUTTOCKS exercises" OR DE "CALISTHENICS" OR DE "CHAIR exercises" OR DE "CHEST exercises" OR DE "CIRCUIT training" OR DE "COMPOUND exercises" OR DE "DO-in" OR DE "EXERCISE – Immunological aspects" OR DE "EXERCISE adherence" OR DE "EXERCISE for children" OR DE "EXERCISE for girls" OR DE "EXERCISE for men" OR DE "EXERCISE for middle-aged persons" OR DE "EXERCISE for older people" OR DE "EXERCISE for people with disabilities" OR DE "EXERCISE for women" OR DE "EXERCISE for youth" OR DE "EXERCISE therapy" OR DE "EXERCISE video games" OR DE "FACIAL exercises" OR DE "FALUN gong exercises" OR DE "FOOT exercises" OR DE "GYMNASTICS" OR DE "HAND exercises" OR DE "HATHA yoga" OR DE "HIP exercises" OR DE "ISOKINETIC exercise" OR DE "ISOLATION exercises" OR DE "ISOMETRIC exercise" OR DE "ISOTONIC exercise" OR DE "KNEE exercises" OR DE "LEG exercises" OR DE "LIANGONG" OR DE "METABOLIC equivalent" OR DE "MULAN quan" OR DE "MUSCLE strength" OR DE "PILATES method" OR DE "PLYOMETRICS" OR DE "QI gong" OR DE "REDUCING exercises" OR DE "RUNNING" OR DE "RUNNING – Social aspects" OR DE "SCHOOLS – Exercises & recreations" OR DE "SEXUAL exercises" OR DE "SHOULDER exercises" OR DE "STRENGTH training" OR DE "STRESS management exercises" OR DE "TAI chi" OR DE "TREADMILL exercise" OR DE "WHEELCHAIR workouts" OR DE "YOGA") OR (DE "PHYSICAL fitness" OR DE "PHYSICAL fitness for older people") OR (DE "SPORTS" OR DE "AERODYNAMICS in sports" OR DE "AERONAUTICAL sports" OR DE "AGE & sports" OR DE "AMATEUR sports" OR DE "ANIMAL sports" OR DE "ANTISEMITISM in sports" OR DE "AQUATIC sports" OR DE "BALL games" OR DE "BALLISTICS in sports" OR DE "BASEBALL" OR DE "BIOMECHANICS in sports" OR DE "COLLEGE sports" OR DE "COMMUNICATION in sports" OR DE "CONTACT sports" OR DE "CROSS-training Sports" OR DE "DISC golf" OR DE "DISCRIMINATION in sports" OR DE "DOG sports" OR DE "DOPING in sports" OR DE "ENDURANCE sports" OR DE "EXTREME sports" OR DE "FANTASY sports" OR DE "FASCISM & sports" OR DE "FEMINISM & sports" OR DE "GAELIC games" OR DE "GAY Games" OR DE "GOODWILL Games" OR DE "GYMNASTICS" OR DE "HOCKEY" OR DE "HOMOPHOBIA in sports" OR DE "HYDRODYNAMICS in sports" OR DE "INDIVIDUAL sports" OR DE "KINEMATICS in sports" OR DE "KNIFE throwing" OR DE "LGBT people & sports" OR DE "LOG-chopping Sports" OR DE "MASCULINITY in sports" OR DE "MASS media & sports" OR DE "MILITARY sports" OR DE "MINORITIES in sports" OR DE "MOTION pictures in sports" OR DE "MOTORSPORTS" OR DE "NATIONAL socialism & sports" OR DE "NATIONALISM & sports" OR DE "NONVERBAL communication in sports" OR DE "OLYMPIC Games" OR DE "PARKOUR" OR DE "PHOTOGRAPHY of sports" OR DE "PHYSICS in sports" OR DE "PRESIDENTS – Sports" OR DE "PROFESSIONAL sports" OR DE "PROFESSIONALISM in sports" OR DE "RACING" OR DE "RACISM in sports" OR DE "RACKET games" OR DE "RADAR in sports" OR DE "RECREATIONAL sports" OR DE "REGIONALISM & sports" OR DE "ROBOTICS in sports" OR DE "RODEOS" OR DE "ROLLER skating" OR DE "SCHOOL sports" OR DE "SENIOR Olympics" OR DE "SEXUAL harassment in sports" OR DE "SHOOTING Sports" OR DE "SHUTOUTS Sports" OR DE "SOCIALISM & sports" OR DE "SOFTBALL" OR DE "SPORT for all" OR DE "SPORTS & state" OR DE "SPORTS & technology" OR DE "SPORTS & theater" OR DE "SPORTS & tourism" OR DE "SPORTS – Collectibles" OR DE "SPORTS – Corrupt practices" OR DE "SPORTS – Economic aspects" OR DE "SPORTS – Finance" OR DE "SPORTS – Folklore" OR DE "SPORTS – Songs & music" OR DE "SPORTS competitions" OR DE "SPORTS for children" OR DE "SPORTS for girls" OR DE "SPORTS for older people" OR DE "SPORTS for people with disabilities" OR DE "SPORTS for women" OR DE "SPORTS for youth" OR DE "SPORTS forecasting" OR DE "SPORTS in antiquity" OR DE "SPORTS penalties" OR DE "SPORTS rivalries" OR DE "SPORTS teams" OR DE "SPORTS tourism" OR DE "STEREOTYPES Social psychology in sports" OR DE "TARGETS Sports" OR DE "TEAM sports" OR DE "TEAMWORK Sports" OR DE "TELEVISION & sports" OR DE "TRACEURS" OR DE "VIDEO tapes in sports" OR DE "VIOLENCE in sports" OR DE "WINTER sports") OR (DE "LOCOMOTION" OR DE "CYCLING" OR DE "HUMAN locomotion")	**503,410**
S13	DE "SEDENTARY lifestyles" OR DE "SEDENTARY behavior" OR DE "SEDENTARY people" OR DE "SEDENTARY women" OR TI (sedent* OR sitting OR "physical inactivit*") OR AB (sedent* OR sitting OR "physical inactivit*")	**18,283**
S12	S3 OR S5 OR S11	**902**
S11	S1 AND S10	**101**
S10	S8 OR S9	**3,691**
S9	DE "HEART rate monitoring"	2,229
S8	S6 AND S7	1,724
S7	DE "Patient Monitoring" OR TI monitoring OR AB monitoring	**15,144**
S6	DE "PULSE (Heart beat)" OR DE "HEART beat" OR TI ("cardiac rate" or "heart rate" or "pulse rate" or "cardiac frequency" or "heart frequency") OR AB ("cardiac rate" or "heart rate" or "pulse rate" or "cardiac frequency" or "heart frequency")	**30,490**
S5	S1 AND S4	**214**
S4	DE "PEDOMETERS" OR TI pedomet* OR AB pedomet*	**1,882**
S3	S1 AND S2	**652**
S2	(DE "ACCELEROMETERS" OR DE "SPEEDOMETERS") OR (TI ((acceleromet* OR actigra*)) OR AB ((acceleromet* OR actigra*)))	**6,650**
S1	((DE "OLDER people" OR DE "EXERCISE for older people" OR DE "OLDER people – Recreation" OR DE "PHYSICAL education for older people" OR DE "PHYSICAL fitness for older people" OR DE "SPORTS for older people") OR DE "GERIATRICS") OR (TI (elder* OR eldest OR frail* OR geriatri* OR "old age*" OR "oldest old*" OR senior* OR senium OR "very old*" OR septuagenarian* OR octagenarian* OR octogenarian* OR nonagenarian* OR centarian* OR centenarian* OR supercentenarian* OR "older people" OR "older subject*" OR "older patient*" OR "older age*" OR "older adult*" OR "older man" OR "older men" OR "older male" OR "older woman" OR "older women" OR "older female" OR "older population*" OR "older person*") OR AB (elder* OR eldest OR frail* OR geriatri* OR "old age*" OR "oldest old*" OR senior* OR senium OR "very old*" OR septuagenarian* OR octagenarian* OR octogenarian* OR nonagenarian* OR centarian* OR centenarian* OR supercentenarian* OR "older people" OR "older subject*" OR "older patient*" OR "older age*" OR "older adult*" OR "older man" OR "older men" OR "older male" OR "older woman" OR "older women" OR "older female" OR "older population*" OR "older person*"))	**57,686**

Appendix B. Newcastle-Ottawa Scale (NOS): adapted for cross-sectional and longitudinal studies

The NOS was adapted for cross-sectional and longitudinal studies, respectively, using the identical methods as the with the addition of two outcome criteria regarding follow-up for longitudinal studies. For cross-sectional studies (maximum score of 7 stars) a score greater than or equal to 4 is classified as high and less than 4 as low. For longitudinal studies (maximum score of 9 stars) a score greater than or equal to 5 is classified as high and a score less than 5 is classified as low quality.

Selection (max. 3 stars)

Representativeness of the sample: community-dwelling older adults

a Truly representative of sample population. Age, gender distribution, country, and kind of population is reported *
b Not representative based on factors mentioned above
c No description

Ascertainment of exposure: physical activity (PA)/sedentary behavior (SB)

a Ascertainment of all physical activity measures reported is clearly and described by name of device, location, and clear cut-off points are reported when appropriate *
b Methodological criteria of PA/SB data were clearly described and all of the following information: total wear time and assessment of valid days (mandatory hours/day and number of valid days) *
c No description

Comparability (max. 3 stars)
Comparability of cohorts on the basis of the design or analysis

a The study controls for the most important factors, age and sex, for at least one association *
b The study adjusted for other or additional factor, e.g. level of education, comorbidities, accelerometer wear time, physical activity for at least one association *
c No controlling for any factors
d No description

1 **Statistical test: method of quantifying relationship of PA/SB and muscle strength/ power**
a The statistical test used to analyze the data is clearly described and appropriate and the measurement of the association is presented clearly including effect size with confidence intervals, p-value (unless $p < 0.001$), or standard error for at least one association *
b The statistical test is not appropriate or incomplete
c No description

Outcome (max. 1 star for cross-sectional studies, 3 stars for longitudinal studies)
Assessment of outcome measure: muscle strength/muscle power

a Clear description of an established method for assessing muscle strength/muscle power with measurement device reported (if applicable) for all measures *
b No description

———— The following are additional criteria assessed for longitudinal studies only ————
Was follow-up long enough for outcome to occur?

a Yes $\geq$ 3 months *
b No <3 months
c Not reported

Adequacy of follow-up of cohorts

a Complete follow up with all subjects accounted for or small number lost (<20 %) *
b Large number lost ($\geq$20 %)
c Not reported

Note Quality was assessed for all articles as described regardless if hypothesized exposure-outcome were reversed (meaning if exposure was muscle strength/muscle power and outcome was PA/SB

Appendix C

Table C1
Characteristics of articles assessing the association of physical activity and sedentary behavior with muscle strength and muscle power in older adults.

Author, year	Cohort	Country	Population selection[a]	Sample size (N)	Age in years mean (SD)	F %	PA/SB measures	Muscle strength/ muscle power measures
Abe et al., 2015	N/A	JP	-	57	66.3 (6.8)	100	Steps, MVPA, LPA-to-MPA	KES, toe grasping strength
Abe et al., 2012	N/A	JP	Healthy	48	65.7 (6.4)	100	Steps, VPA, MPA, LPA, EE	KES, knee flexion strength
Aggio et al., 2016	BRHS	GB	-	1286 (*Non-sarcopenia:* 1033; *Sarcopenia:* 183; *Severe sarcopenia:* 70)	*Non-sarcopenia:* 7.6 (4.1); *Sarcopenia:* 79.7 (4.7); *Severe sarcopenia:* 83.1 (5.2)	0.0	MVPA, LPA, SB, BST	HGS
Alcazar et al., 2018	N/A	ES	-	31	75.8 (4.7)	54.8	MVPA, SB	Leg press strength, leg press power
Alzahrani et al., 2012	N/A	N/R	After stroke	42	70 (10)	31.0	Activity counts, TPA, MVPA	KES
Andersson et al., 2013	N/A	SE	COPD	72	65 (7)	61.1	EE *(PAL)*	KES
André et al., 2018	N/A	PT	Healthy	29	73.2 (6.6)	50.0	MVPA	Calf raise
André et al., 2016	N/A	PT	Healthy	28	73.9 (7.7)	56.1	MVPA	Calf raise
Aoyagi et al., 2009	Nakanojo	JP	-	170	72.7 (4.6)	55.3	Steps, TPA	HGS, knee extension torque
Ashe et al., 2008	N/A	N/R	-	73	68.8 (3)	100	Activity counts, MVPA	KES, leg press power
Ashe et al., 2007	N/A	N/R	Chronic disease	200	74.4 (5.7)	65.0	Steps	HGS, KES
Aubertin-Leheudre et al., 2017	LIFE	US	Mobility limited and sedentary	1453 (*Non-obese non-dynapenic:* 402; *Non-obese dynapenic:* 381; *Obese non-dynapenic:* 414; *Obese dynapenic:* 256)	78.8 (5.3)	66.0	Steps, activity counts, TPA	HGS
Balducci et al., 2017	N/A	IT	Diabetes	300	61.6 (9.9)	38.7	MVPA, LPA, SB	Shoulder press strength, leg press strength
Bann et al., 2015	LIFE	US	Mobility limited and sedentary	1130 (*M:* N/R; *F:* N/R)	*M:* 79.3 (5.3); *F:* 78.5 (5.3)	N/R ~67	TPA, LPA, SB	HGS
Barbat-Artigas et al., 2012	N/A	CN	Post-menopausal	57 (*Sedentary:* 19; *Moderate active:* 20; *Active:* 18)	61 (5)	100	Steps, TPA	HGS, KES, 20 s CST
Bartlett and Duggal, 2020	N/A	N/R	Healthy	50	*Sedentary:* 63.4 (4.4); *Active:* 67.0 (6.0)	*Sedentary:* 52; *Active:* 56	Steps	HGS
Bassey et al., 1988	N/A	GB	-	125	*M:* 71 (4); *F:* 72 (4)	53.6	Steps	Calf strength
Bogucka et al., 2018	N/A	PL	Post-menopausal	46 (*Dynapenic:* 10; *Non-dynapenic:* 36)	71.4 (5.6)	100	Steps	HGS
Bollaert and Motl, 2019	N/A	US	MS and HC	80 (*MS:* 40; *HC:* 40)	*MS:* 65.3 (4.3); *HC:* 66.5 (6.7)	62.5	MVPA, LPA, SB, PA bouts, SB bouts, long SB bouts	5x CST
Boutou et al., 2019	PROactive	GB, NL, GR, BE	COPD	157	67.2 (7.8)	24.2	ΔSteps, ΔMVPA, ΔMET, ΔVMU	KES
Carrasco Poyatos et al., 2016	N/A	ES	-	42 (*MPA group:* 19; *VPA group:* 15)	70.1 (4.5)	100	VPA, MVPA, MPA	HGS
Chastin et al., 2012	N/A	GB	Healthy	30	*F:* 79.3 (3.4); *M:* 79.0 (3.6)	46.7	SB, SB break rate	Leg extension power
Chmelo et al., 2013	IDEA	US	OA, high BMI, and sedentary	160	66 (6)	69.0	Steps, MVPA LPA, EE	KES
Cooper et al., 2015	MRC NSHD	GB	-	1727	63.3 {60.3-64.9}	51.5	MVPA, SB, EE	HGS, 10x CST
Davis et al., 2014	OPAL	GB	-	217	78.1 (5.8)	50.2	MVPA, SB, BST	5x CST
de Melo et al., 2010[d]	N/A	CN	-	60	77 (7.3)	75.0	Steps	30 s CST
de Melo et al., 2014[d]	N/A	CN	-	60	77 (7.3)	75.0	Steps	Arm curl, 30 s CST
Demeyer et al., 2019	PAC-COPD	ES	COPD	114	70 (8)	N/R	ΔSteps, steps, MVPA	ΔHGS
Distefano et al., 2018	N/A	US	-	29 (*Active:* 10; *Sedentary:*19)	*Active:* 67.5 (2.7); *Sedentary:* 70.7 (4.7)	*Active:* 20.0; *Sedentary:* 42.1	Steps	KES, 5x CST

(*continued on next page*)

Table C1 (*continued*)

Author, year	Cohort	Country	Population selection[a]	Sample size (N)	Age in years mean (SD)	F %	PA/SB measures	Muscle strength/ muscle power measures
Dogra et al., 2017	N/A	CN	-	1157	64 (95% CI: 64-64)	46.6	BST, long SB bouts	HGS
Dohrn et al., 2020	SNAC-K	SE	-	656	73.3 (9.0)	64.0	Steps	5x CST
Dos Santos et al., 2019	N/A	BR	-	375	70 (7)	69.6	MVPA	HGS
Duncan et al., 2016	N/A	GB	-	201	66.1 (7.7)	59.7	Steps	Arm curl, 30 s CST
Edholm et al., 2019	N/A	SE	-	60	67.5 (15)	100	Activity counts, MVPA	Squat jump test
Foong et al., 2016	TASOAC	AU	-	636	66 (7)	50.8	Activity counts, VPA, MPA, LPA, SB	KES, leg strength
Gennuso et al., 2016	N/A	US	-	44 (*M*: 16; *F*: 28)	*M:* 71 [69-74]; *F:* 70 [67-78]	63.6	SB, BST, SB break rate, SB bouts, long SB bouts	5x CST
Gerdhem et al., 2007	OPRA	SE	≥80 years	57	80.1 (0.1)	100	Activity counts, MVPA	KES, Knee flexion strength
Hall et al., 2016	MURDOCK	US	-	775 (*60-69y*: 196, *70-79y*: 198, *80-90+y*: 92)	62.1 (SD N/R) (*60-69y*: 64.8, *70-79y*: 73.6, *80-90+y*: 83.6)	53.2 (*60-69y*: 50.5, *70-79y*: 49.5, *80-90+y*: 64.1)	Steps, MVPA, SB	30 s CST
Harada et al., 2016	NCGG	JP	Global cognitive impairment	192	76.2 (4.1)	44.7	Steps	5x CST
Hartley et al., 2018	COSHIBA	GB	-	242	76.4 (2.6)	100	Activity counts	Jump strength, 5x CST, jump power
Hasegawa et al., 2018	N/A	JP	-	50	77.8 (5.3)	74.0	Steps	30 s CST
Hernandes et al., 2013	N/A	BR	+/- exercise lifestyle	238 (*Exercise*: 134; *Non-exercise*: 104)	*Exercise:* 68 [64-71]; *Non-exercise:* 68 [64-71]	*Exercise:* 39.1; *Non-exercise:* 69.3	Steps	HGS, 30 s CST
Hernández et al., 2017	N/A	ES	COPD (moderate-severe)	44	70.3 (6.7)	0.0	TPA, MPA, LPA, SB	Quadriceps power at 50% and 70% 1RM, respectively
Hopkins, 2019	OAI	US	OA	687	*Inactive:* 65.7 (0.44); *Active:* 61.3 (0.48)	*Inactive:* 69.8; *Active* 44.3	MVPA	Δ5x CST
Iijima et al., 2017	N/A	JP	OA	207 (*Basal activity:* 58; *Limited activity:* 79; *Low Active:* 45; *Physically active:* 25)	*Basal activity:* 76.4 (8.89); *Limited activity:* 73.4 (6.83); *Low Active:* 70.0 (6.48); *Physically active:* 70.4 (6.00)	71.5	Steps	5x CST
Ikenaga et al., 2014	N/A	JP	-	178	73.7 (2.6)	0.0	Steps, MPA, LPA, SB	HGS, KES
Iwakura et al., 2016	N/A	N/R	COPD	22	71.6 (6.9)	0.0	Steps	5x CST
Jantunen et al., 2017	Helsinki Birth	FI	-	695	70.7 (2.7)	54.5	MET	Arm curl, 30 s CST
Jeong et al., 2019	N/A	KR	-	52	60.3 (5.6)	90.4	Steps	Hip strength, KES
Johnson et al., 2016	TASOAC	AU	-	188	64.0 (7.3)	53.7	VPA, MPA, LPA, SB	Leg strength
Kawagoshi et al., 2013	N/A	JP	COPD	26	77 (6)	0.0	Steps, TPA, LPA, SB	KES
Keevil et al., 2016	EPIC-Norfolk	GB	-	3726 (*M*: 1674; *F*: 2052)	*M:* 69.8 (7.6); *F:* 68.0 (7.5)	55.1	MVPA, SB	HGS, CST
Kim, 2015	N/A	JP	-	207	83.5 (2.6)	55.5	Activity counts	HGS, KES
Kim et al., 2015	N/A	JP	-	101	81.4 (2.8)	100	Activity counts, MVPA, LPA, SB, long SB bouts	5x CST
Lai et al., 2020	N/A	TW	Independent walking without assistive device	122	69.9 (5.0)	71.3	MVPA	5x CST
Lee et al., 2015	OAI	US	Knee OA	1168	66 (N/R)	55.0	SB	5x CST
Lerma et al., 2018		US	-	91	70.7 (10.2)	60.0	MVPA, LPA, SB	5x CST
Liao et al., 2018	N/A	JP	-	281	74.5 (5.2)	38.1	SB, SB break rate, long SB bouts	HGS
Lohne-Seiler et al., 2016	2 N/R cohorts	NO	-	161 (*M:* 76; *F:* 85)	*M:* 72.3 (4.8); *F:* 73.2 (5.4)	52.8	Steps	HGS
Mador et al., 2011	N/A	US	COPD	28	71.9 (7.7)	N/R	VMU	KES
Master et al., 2018	OAI	US	Knee OA	1925	65.1 (9.1)	55.0	Steps	5x CST

(*continued on next page*)

Table C1 (*continued*)

Author, year	Cohort	Country	Population selection[a]	Sample size (N)	Age in years mean (SD)	F %	PA/SB measures	Muscle strength/ muscle power measures
Matkovic et al., 2020	N/A	HR	COPD	111	67.7 (7.8)	31.5	Steps	HGS, 30 s CST
McDermott et al., 2002	N/A	US	+/- PAD	346	71.2 (8.3)	41.6	Accelerations	5x CST
McGregor et al., 2018	CHMS	CN	-	1454	69.3 (0.3)	52.4	MVPA, LPA, SB	HGS
Meier and Lee, 2020	PAAS	US	-	304	72.8 (5.8)	58.2	Steps	HGS, chest press strength, leg press strength
Monteiro et al., 2019	N/A	PT	Caucasian	60	67.7 (5.3)	100	Activity counts	Arm curl, KES, knee flexion strength, 30 s CST
Morie et al., 2010	N/A	US	Mobility limited & low testosterone	82	74.1 (5.3)	0.0	Activity counts	Chest press strength, chest press power, leg press strength, leg press power
Nagai et al., 2018	N/A	JP	-	886	73.6 (7.0)	70.0	MVPA, LPA, SB	HGS
Nawrocka et al., 2017	N/A	PL	-	61 (*Not meeting PA guidelines:* 39; *Meeting PA guidelines:* 22)	66.2 (4.4)	100	MVPA	Arm curl
Nawrocka et al., 2019	N/A	PL	-	213 (*Not meeting PA guidelines:* 108; *Meeting PA guidelines:* 105)	N/R	100	MVPA	HGS, Arm curl, 30 s CST
Nicolai et al., 2010	N/A	GB	-	44	80.8 (4.1)	N/R	Steps (*walking*), TPA (*standing*)	5x CST
Ofei-Doodoo et al., 2018	N/A	US	Sedentary	101	75.0 (7.2)	100	MVPA	Arm curl, 30 s CST
Orwoll et al., 2019	MrOS	US	-	2741 (*No falls:* 1777; *One fall: 327;* ≥ *Two falls:* 63)	78.8 (5)	0.0	MVPA, LPA	5x CST
Osuka et al., 2015	N/A	JP	-	802	72.5 (5.9)	76.7	MVPA, LPA	5x CST
Park et al., 2018	N/A	KR	-	22	71.5 (3.3)	0.0	Steps	HGS, 30 s CST
Perkin et al., 2018	N/A	GB	Healthy	50	69 (4)	46	MVPA, SB, EE	Leg press strength, leg press power
Pitta et al., 2005	N/A	BE	COPD	50	77.3 (7.0)	28	Steps (*walking*), TPA (*standing*)	HGS, knee extension torque
Puthoff et al., 2008	N/A	N/R	Mild-moderate functional limitations	30	77.3 (7.0)	83.3	Steps	Leg press strength, leg press power
Rapp et al., 2012	ActiFE Ulm	DE	-	1271	*M:* 76.0 (6.46); *F:* 75.1 (6.58)	43.6	Steps (*walking*)	HGS, 5x CST
Rausch-Osthoff et al., 2014	N/A	CH	COPD	27	62.3 (5.7)	40.7	Steps, EE, EE (*PAL*), MET	KES
Rava et al., 2018	N/A	EE	-	81	73.1 (5.3)	100	VPA, MVPA, MPA, LPA, SB	5x CST
Reid et al., 2018	N/A	AU	-	123	70.9 (4.2)	63	SB, BST	KES, leg press strength, 30 s CST
Rojer et al., 2018	Grey Power	NL	-	80	74.4 [72.4-78.0]	60.0	Steps, TPA, SB, PA bouts, SB bouts	HGS
Rosenberg et al., 2015	N/A	US	Retirement communities	307	83.6 (6.4)	72.3	SB	5x CST
Rowlands et al., 2018	CODEC	GB	Type II diabetes	295	63.2 (9.7)	39.7	MVPA, accelerations, intensity gradient, PA bouts	HGS, 60 s CST
Safeek et al., 2018	N/A	US	HIV	21	66.1 (6.3)	33.3	Steps, MVPA, LPA, SB, EE	HGS, 30 s CST
Sánchez-Sánchez et al., 2019	TSHA	ES	-	512	78.1 (5.7)	54.3	Activity counts, MVPA, LPA, SB	HGS
Santos et al., 2012	N/A	PT	-	312	74.3 (6.6)	62.5	MVPA, SB	Arm curl, 30 s CST
Sardinha et al., 2015	N/A	PT	-	215	73.3 (5.9)	59.5	BST	Arm curl, 30 s CST
Scott et al., 2020	Healthy Ageing Initiative	SE	-	3334 (*Non-sarcopenic:* 3273; *Sarcopenic:* 61)	*Non-sarcopenic:* 70.01 (0.10); *Sarcopenic:* 70.02 (0.13)	*Non-sarcopenic:* 50.5;	MVPA, LPA, SB	HGS

(*continued on next page*)

Table C1 (*continued*)

Author, year	Cohort	Country	Population selection[a]	Sample size (N)	Age in years mean (SD)	F %	PA/SB measures	Muscle strength/ muscle power measures
						Sarcopenic: 57.4		
Scott et al., 2011	TASOAC	AU	-	697	61.9 (7.2)	49.5	Steps	Leg strength
Scott et al., 2009	TASOAC	AU	-	982	62 (7)	51	Steps	Leg strength
Semanik et al., 2015	OAI	US	OA	1659	64.8 (9.0)	54.7	SB	5x CST
Silva et al., 2019	N/A	PT	Physically independent	83	72.14 (5.61)	67.5	MVPA, LPA, SB	Arm curl, 30 s CST
Spartano et al., 2019	FOS	US	-	1352	68.6 (7.5)	54.0	Steps, MVPA, SB	HGS, 5x CST
Tang et al., 2015	N/A	US	Severe Aortic Stenosis	51	88 [85-90]	63	Activity counts	HGS
Trayers et al., 2014	OPAL	GB	-	240	78 (6)	48	Steps, counts, MVPA	5x CST
Van Gestel et al., 2012	N/A	SE	COPD	70	62.4 (7.4)	30.0	Steps	HGS, 60 s CST
Van Lummel et al., 2016	N/A	NL	-	57	84.0 (11.0)	82.5	TPA, PA bouts, SB bouts	5x CST
van Oeijen et al., 2020	N/A	NL	CIAP	92	65 (13.75)	27.2	Steps	Lower extremity strength
Van Sloten et al., 2011	N/A	NL	Diabetes	100	64.5 (9.4)	31.0	Steps	HGS
Walker et al., 2008	N/A	N/R	COPD	23	66 (9)	47.8	TPA	KES
Ward et al., 2014	N/A	N/R	-	156	68.9 (6.7)	45.5	Activity counts, MVPA	30 s CST
Waschki et al., 2012	N/A	GB & NL	COPD	104	64.6 (7.2)	39.2	Steps, EE *(PAL)*	KES
Watz et al., 2008	N/A	DE	COPD	170	64.0 (6.6)	24.7	Steps, EE *(PAL)*	HGS
Westbury et al., 2018	HSS	GB	-	131 (*M:* 32; F: 99)	*M:* 78.6 (2.7); *F:* 78.9 (2.3)	75.6	TPA, MVPA, accelerations	HGS
Wickerson et al., 2013	N/A	CN	Interstitial lung disease	24	62 [53-65]	41.7	Steps, MVPA	Knee extension torque
Winberg et al., 2015	N/A	SE	Polio history	77	67 (6)	45.5	Steps	KES, knee flexion strength
Yamada et al., 2011	N/A	JP	-	629 (*Non-frail:* 515; *Frail:* 114)	*Non-frail:* 77.0 (7.2); *Frail:* 76.1 (7.5)	67.5	Steps	5x CST
Yasunaga et al., 2017	N/A	JP	-	287	74.4 (5.2)	37.3	MVPA, LPA, SB	HGS
Yoshida et al., 2010	N/A	JP	Day care center attendees	147	82.8 (4.3)	100	Steps, TPA, MPA, LPA	HGS, KES
Yuki et al., 2019	NILS-LSA	JP	-	401	71.1 (4.3)	44.4	Steps, LPA, MVPA	HGS

Age in years is presented as mean (standard deviation) or otherwise median [interquartile range] or mean {range}. Gender distribution is presented as the percentage of females within the study population. Subgroups are presented in italics with their sample size (N) and any other reported information in parentheses.
N = sample size, M = male, F = female, N/R = not reported, N/A = not applicable, BRHS = British Regional Heart Study, LIFE = Lifestyle Interventions and Independence for Elders, IDEA = Intensive Diet and Exercise for Arthritis, MRC NSHD = Medical Research Council National Survey of Health and Development, OPAL = Older People and Active Living, PAC-COPD = Phenotype Characterization and Course of Chronic Obstructive Pulmonary Disorder, CIAP = chronic idiopathic axonal polyneuropathy, TASOAC = Tasmanian Older Adult Cohort, OPRA = Osteoporosis Prospective Risk Assessment study, MURDOCK= The Measurement to Understand the Reclassification of Disease Of Cabarrus/Kannapolis, NCGG = National Center for Geriatrics and Gerontology-Study, COSHIBA=Cohort of Skeletal Health in Bristol and Avon, EPIC-Northfolk = European Prospective Investigation into Cancer in Northfolk, OAI = Osteoarthritis Initiative, CHMS = Canadian Health Measure Survey, MrOS = The Osteoporotic Fractures in Men Study, ActiFE Ulm = Activity and Function in the Elderly in Ulm, CODEC = Chronotype of Patients with Type 2 Diabetes and Effect on Glycaemic Control, TSHA = Toledo Study of Healthy Aging, FOS = Framingham Offspring Study, HSS=Hertford Sarcopenia Study, NILS-LSA = National Institute for Longevity Sciences-Longitudinal Study of Aging, PAAS = Physical Activity and Aging Study, SNAC-K = National study on Aging and Care in Kungsholmen, JP = Japan, GB = Great Britain, ES = Spain, PT = Portugal, US = United States, IT = Italy, CN = Canada, PL = Poland, BR = Brazil, SE = Sweden, FI = Finland, AU = Australia, NO = Norway, DE = Germany, CH = Switzerland, EE = Estonia, NL = Netherlands, HR = Croatia, TW = Tawain, MS = multiple sclerosis, HC = healthy controls, OA = osteoarthritis, BMI = body mass index, COPD = chronic obstructive pulmonary disorder, PAD = peripheral artery disease, N = sample size, M = male, F = female, TPA = total physical activity, MPA = moderate physical activity, VPA = vigorous physical activity, MVPA = moderate to vigorous physical activity, LPA = light physical activity, SB = sedentary behavior, EE = energy expenditure, PAL = physical activity units, BST = breaks in sedentary time, Δ=change, MET = metabolic equivalent of tasks, VMU = vector magnitude units, HGS = hand grip strength, KES = knee extension strength, CST = chair stand test, s = seconds, x = times (repetitions), 1RM = one repetition maximum.

[a] Population selection refers to any specific for criteria for selection other than sex (e.g. disease or demographic characteristic), studies with no selection were selected from a community-based sample or the general population left blank with a dash.

Table C2
Assessment of methodological quality of included articles based on the adapted Newcastle-Ottawa Scale (NOS).

Author year	Selection			Comparability			Outcome			Score	Quality
	Q1	$Q2_{a,b}$		$Q3_{a,b}$		Q4	Q5	Q6[L]	Q7[L]		
Abe et al., 2015	*	*	-	*	*	-	*			5/7	high
Abe et al., 2012	*	*	-	*	-	-	*			4/7	high
Aggio et al., 2016	*	*	*	*	*	*	*			7/7	high
Alcazar et al., 2018	*	*	-	-	-	-	*			3/7	low
Alzahrani et al., 2012	-	*	-	-	-	*	*			3/7	low
Andersson et al., 2013	*	-	-	*	*	*	*			5/7	high
André et al., 2018	*	*	-	-	-	*	*			4/7	high
André et al., 2016	*	*	-	-	-	*	*			4/7	high
Aoyagi et al., 2009	*	*	-	*	-	-	*			4/7	high
Ashe et al., 2008	-	*	*	-	-	*	*			4/7	high
Ashe et al., 2007	-	-	-	-	-	-	*			1/7	low
Aubertin-Leheudre et al., 2017	*	-	-	-	-	*	-			2/7	low
Balducci et al., 2017	-	*	-	-	-	-	-			1/7	low
Bann et al., 2015	*	*	-	*	*	*	*			6/7	high
Barbat-Artigas et al., 2012	*	*	-	-	-	-	*			3/7	low
Bartlett and Duggal, 2020	-	-	-	-	-	*	-			1/7	low
Bassey et al., 1988	*	-	-	-	-	-	*			2/7	low
Bogucka et al., 2018	*	-	-	-	-	*	*			3/7	low
Bollaert and Motl, 2019	*	-	-	-	*	*	-			3/7	low
Boutou et al., 2019	*	*	-	-	*	*	-	*	-	5/9	high
Carrasco Poyatos et al., 2016	-	-	*	-	-	*	*			3/7	low
Chastin et al., 2012	*	*	-	-	-	*	-			3/7	low
Chmelo et al., 2013	*	*	-	-	-	*	-			3/7	low
Cooper et al., 2015	*	*	*	*	*	*	*			7/7	high
Davis et al., 2014	*	*	*	*	*	*	*			7/7	high
de Melo et al., 2010	*	-	-	-	*	*	*			4/7	high
de Melo et al., 2014	*	-	-	*	*	*	*			5/7	high
Demeyer et al., 2019	*	*	*	-	-	-	-	*	-	4/9	low
Distefano et al., 2018	*	*	-	*	-	*	*			5/7	high
Dogra et al., 2017	*	*	-	*	*	*	*			6/7	high
Dohrn et al., 2020	*	*	*	*	*	*	*			7/7	high
Dos Santos et al., 2019	*	*	-	-	-	*	*			4/7	high
Duncan et al., 2016	*	*	-	-	-	*	*			4/7	high
Edholm et al., 2019	*	*	*	-	*	*	*			6/7	high
Foong et al., 2016	*	*	-	-	-	*	*			4/7	high
Gennuso et al., 2016	*	*	*	*	*	-	-			5/7	high
Gerdhem et al., 2007	*	*	*	-	-	*	*			5/7	high
Hall et al., 2016	*	-	*	-	-	*	*			4/7	high
Harada et al., 2016	*	*	-	-	-	*	*			4/7	high
Hartley et al., 2018	*	*	-	*	-	*	*			5/7	high
Hasegawa et al., 2018	*	*	-	*	-	*	*			5/7	high
Hernandes et al., 2013	*	*	-	-	-	-	*			3/7	low
Hernández et al., 2017	*	*	-	-	*	*	*			5/7	high
Hopkins 2019	*	-	-	*	*	-	*	*	-	5/9	high
Iijima et al., 2017	*	-	-	*	*	*	*			5/7	high
Ikenaga et al., 2014	*	-	-	-	*	*	-			3/7	low
Iwakura et al., 2016	*	*	-	-	-	-	*			3/7	low
Jantunen et al., 2017	*	*	*	*	*	*	*			7/7	high
Jeong et al., 2019	*	*	-	-	-	-	*			3/7	low
Johnson et al., 2016	*	*	*	-	-	-	*			4/7	high
Kawagoshi et al., 2013	*	*	*	-	-	-	*			4/7	high
Keevil et al., 2016	*	*	*	*	*	*	*			7/7	high
Kim 2015	*	*	-	*	-	*	*			5/7	high
Kim et al., 2015	*	*	*	*	*	*	*			7/7	high
Lai et al., 2020	*	*	*	*	*	*	*			7/7	high
Lee et al., 2015	*	*	*	*	*	*	*			7/7	high
Lerma et al., 2018	*	*	-	*	*	*	*			6/7	high
Liao et al., 2018	*	*	*	*	*	*	*			7/7	high
Lohne-Seiler et al., 2016	*	*	*	*	*	*	*			7/7	high
Mador et al., 2011	*	-	*	-	-	*	*			4/7	high
Master et al., 2018	*	*	-	*	*	*	*			6/7	high
Matkovic et al., 2020	*	-	-	-	-	*	*			3/7	low
McDermott et al., 2002	*	*	-	-	-	*	*			4/7	high
McGregor et al., 2018	*	*	-	*	*	*	-			5/7	high
Meier and Lee, 2020	*	-	-	*	*	*	*			5/7	high
Monteiro et al., 2019	*	*	-	-	-	*	*			4/7	high
Morie et al., 2010	*	*	-	-	-	-	*			3/7	low
Nagai et al., 2018	*	*	*	-	-	-	*			4/7	high
Nawrocka et al., 2017	*	*	-	-	-	*	*			4/7	high
Nawrocka et al., 2019	-	*	-	-	-	*	*			3/7	low
Nicolai et al., 2010	-	*	-	-	-	-	*			2/7	low
Ofei-Doodoo et al., 2018	*	-	-	-	-	*	*			3/7	low
Orwoll et al., 2019	*	*	-	-	-	*	*			4/7	high

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Table C2 (*continued*)

Author year	Selection			Comparability			Outcome			Score	Quality
	Q1	$Q2_{a,b}$		$Q3_{a,b}$		Q4	Q5	$Q6^L$	$Q7^L$		
Osuka et al., 2015	*	*	*	*	*	*	*			7/7	high
Park et al., 2018	*	*	-	-	-	-	-			2/7	low
Perkin et al., 2018	*	*	-	-	-	-	*			3/7	low
Pitta et al., 2005	*	*	-	-	-	*	*			4/7	high
Puthoff et al., 2008	-	*	*	-	-	-	-			2/7	low
Rapp et al., 2012	*	*	*	*	-	*	*			6/7	high
Rausch-Osthoff et al., 2014	*	*	-	-	-	*	*			4/7	high
Rava et al., 2018	*	*	-	*	*	-	*			5/7	high
Reid et al., 2018	*	-	-	*	*	*	*			5/7	high
Rojer et al., 2018	*	*	*	*	*	*	*			7/7	high
Rosenberg et al., 2015	*	*	*	*	*	*	*			7/7	high
Rowlands et al., 2018	*	*	*	*	*	*	-			6/7	high
Safeek et al., 2018	*	*	*	-	-	-	*			4/7	high
Sánchez-Sánchez et al., 2019	*	*	*	*	*	*	*			7/7	high
Santos et al., 2012	*	*	*	*	*	*	*			7/7	high
Sardinha et al., 2015	*	*	*	*	*	-	*			6/7	high
Scott et al., 2020	*	*	*	-	*	*	*			6/7	high
Scott et al., 2011	*	*	*	-	*	*	*	*	*	8/9	high
Scott et al., 2009	*	*	*	-	-	*	*			5/7	high
Semanik et al., 2015	*	*	*	*	*	*	*	*	*	9/9	high
Silva et al., 2019	*	*	*	-	-	*	*			5/7	high
Spartano et al., 2019	*	*	*	*	*	*	*			7/7	high
Tang et al., 2015	*	*	-	-	*	*	*			5/7	high
Trayers et al., 2014	*	-	-	*	*	*	*			5/7	high
Sullivan and Feinn, 2012	*	*	-	-	*	*	*			5/7	high
Van Lummel et al., 2016	*	*	-	-	-	*	*			4/7	high
van Oeijen et al., 2020	*	-	-	-	-	*	-	*	-	3/9	low
Van Sloten et al., 2011	*	*	-	-	-	*	-			3/7	low
Walker et al., 2008	-	*	-	-	-	*	*			3/7	low
Ward et al., 2014	*	*	-	*	*	*	*			6/7	high
Waschki et al., 2012	*	*	*	*	*	*	*			7/7	high
Watz et al., 2008	*	*	-	-	*	-	-			3/7	low
Westbury et al., 2018	*	*	-	*	*	*	*			6/7	high
Wickerson et al., 2013	*	*	-	-	-	*	*			4/7	high
Winberg et al., 2015	*	*	-	*	*	-	*			5/7	high
Yamada et al., 2011	*	*	-	*	*	-	*			5/7	high
Yasunaga et al., 2017	*	*	*	*	*	*	*			7/7	high
Yoshida et al., 2010	*	-	-	-	-	-	*			2/7	low
Yuki et al., 2019	*	*	-	*	*	-	-	*	*	6/9	high

Q = questions, L = questions applicable to longitudinal studies only, quality was assessed using a cut-off for high quality of $\geq$ 4/7 for cross-sectional studies and $\geq$5/9 for longitudinal studies, and otherwise articles were classified low quality.
*represents point awarded, - (dash) represents no point awarded, blank represents N/A, underlined articles are longitudinal design.
Q1:*Age, gender distribution, country, and kind of population is reported $Q2_a$:*Ascertainment of all physical activity measures reported is clearly and described by name of device, location, and clear cut-off points are reported when appropriate, $Q2_b$:*Methodological criteria of PA/SB data were clearly described and all of the following information: total wear time and assessment of valid days (mandatory hours/day and number of valid days) (2 possible * for Q2) $Q3_a$:*The study controls for the most important factors, age and sex, for at least one association, $Q3_b$:*The study adjusted for other or additional factor, e.g. level of education, comorbidities, accelerometer wear time, physical activity for at least one association (2 possible * for Q3) Q4:*The statistical test used to analyze the data is clearly described and appropriate and the measurement of the association is presented clearly including effect size with confidence intervals, p-value (unless $p < 0.001$), or standard error for at least one association Q5:*Clear description of an established method for assessing muscle strength/muscle power with measurement device reported (if applicable) for all measures $Q6^L$:*Follow-up $\geq$ 3 months (applicable for longitudinal studies only) $Q7^L$:*Complete follow up with all subjects accounted for or small number lost (<20 %) months (applicable for longitudinal studies only).

Table C3
Ascertainment and measurement characteristics of objectively measured physical activity and sedentary behavior.

Author year	Device and wearing protocol				Assessment of valid days			Physical activity and sedentary behavior			
	A/P	Name	Worn on	# days worn	Defined as minimum (h/day)	# valid days required	Wear time mean (SD) (min/day)	Reported measure(s)[a]	Units	Cut off values/definition	Mean (SD)
Abe et al., 2015	A	Lifecorder EX	Hip	30	N/R	30	N/R	Steps	#/day	Device detected	7974 (3041)
								MVPA	Min/day	≥3 MET	23.7 (17.1)
								LPA (*LPA-MPA*)	Min/day	<3-6 MET	82.2 (29.1)
Abe et al., 2012	A	Lifecorder EX	Hip	30	N/R	30	N/R	Steps	#/day	Device detected	7996 (3180)
								VPA	Min/day	>6 MET	1.6 (1.6)
								MVPA (*MPA*)	Min/day	3-6 MET	22.5 (16.8)
								LPA	Min/day	<3 MET	59.4 (20.8)
								EE	Kcal/day	Device detected	181 (85)
Aggio et al., 2016	A	Actigraph GT3X	Hip	7	10	3	N/R	MVPA	Min/day	>1040 CPM	*Non-sarcopenia:* 42.1, (95% CI: 40.1, 44.0); *Sarcopenia:* 37.9 (95% CI: 32.8, 43.1); *Severe sarcopenia*: 19.8 (95% CI: 14.4, 25.1)
								LPA	Min/day	100-1040 CPM	*Non-sarcopenia:* 201.9 (95% CI: 198.1, 205.6); *Sarcopenia:* 196.4 (95% CI:187.1, 205.7); *Severe sarcopenia*: 169.2 (95% CI: 152.5, 185.9)
								SB	Min/day	<100 CPM	*Non-sarcopenia:* 610.9 (95% CI: 606.0, 615.7); *Sarcopenia:* 614.1 (95% CI: 602.1, 626.1); *Severe sarcopenia*: 650.6 (95% CI: 632.0, 669.2)
								BST	#/h	N/R	*Non-sarcopenia:* 7.3 (95% CI: 7.2, 7.4); *Sarcopenia:* 7.3 (95% CI: 7.0, 7.6); *Severe sarcopenia*: 6.6 (95% CI: 6.0, 7.1)
Alcazar et al., 2018	A	Acti Trainer	Hip	7	8	4	N/R	MVPA	% time/day	≥1952 CPM	N/R
								SB	% time/day	<100 CPM	N/R
Alzahrani et al., 2012	A	IDEEA	Waist	2	N/R	N/R	10.8 (1.3) h/day	Activity counts	#/day	Total # of steps + stairs + sit to stands	5656 (4091)
								TPA *(On feet)*	Min/day	Total duration of walking + stairs + standing + sit to stands	230 (115)
Andersson et al., 2013	A	ActiReg	Waist, thigh, and chest	7	N/R	N/R	N/R	EE *(PAL)*	None	Calculated as EE from ActiReg/resting metabolic rate from indirect calorimetry	1.47 (0.19
André et al., 2018	A	Actigraph GT1M	Hip	5	10 h/day or 3000 activity counts	4	N/R	MVPA	Min/day	≥1952 CPM	35.3 (28.8)
André et al., 2016	A	Actigraph GT1M	Hip	7	10 h/day or 3000 activity counts	4	N/R	MVPA (less vs. more active)	Dichotomous min/day	< vs. ≥ 30 min/day	31.83 (28.3)
Aoyagi et al., 2009	A	Kenz Lifecoder	Waist	1 year	N/R	N/R	N/R	Steps	# /day	Device detected	6574 (2715)
								TPA	Min/day	>3 MET	17.3 (11.9)
Ashe et al., 2008	A	Actigraph GT1M	waist	N/R	10	4[a]	6 (1) days		#/day	Device detected	244384 (116423)

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Table C3 (*continued*)

Author year	Device and wearing protocol: A/P	Name	Worn on	# days worn	Assessment of valid days: Defined as minimum (h/day)	# valid days required	Wear time mean (SD) (min/day)	Physical activity and sedentary behavior: Reported measure(s)[a]	Units	Cut off values/definition	Mean (SD)
								Activity counts			
								MVPA	Min/day	>574 CPM	156 (90)
								Steps	#/day	Device detected	
Ashe et al., 2007	P	New Lifestyles Digiwalker	N/R	3	N/R	N/R	N/R	Steps (high vs. low)	Dichotomous #/day	< or > 7500 steps/day	6078 (4031)
								Steps	#/day	Device detected	*Non-obese non-dynapenic*: 2938 (1573); *Non-obese dynapenic*: 2703 (1703); *Obese non-dynapenic*: 2622 (1327); *Obese dynapenic*: 2406 (1199)
Aubertin-Leheudre et al., 2017	A	Actigraph GT3X	Hip	N/R	10	3	N/R	Activity counts	#/day	Device detected	*Non-obese non-dynapenic*: 95617 (49660); *Non-obese dynapenic*: 84046 (51892); *Obese non-dynapenic*: 94160 (49862); *Obese dynapenic*: 84995 (43571)
								TPA	Min/day	>500 CPM	*Non-obese non-dynapenic*: 55.8 (36.6); *Non-obese dynapenic*: 46.0 (35.2); *Obese non-dynapenic*: 57.3 (38.3); *Obese dynapenic*: 49.8 (34.4)
								MVPA	Min/day	≥1952 CPM	12.4 (4.6)
Balducci et al., 2017	A	My Wellness Key	Hip	7	N/R	N/R	N/R	LPA	H/day	100-1951	3.93 (1.35)
								SB	H/day	<100 CPM	11.6 (1.2)
								TPA	H/day	Device detected	*M:* 168.7 (67.0); *F:* 202.0 (67.9)
								Lower-LPA	H/day	100-1040 CPM	*M:* 152.6 (55.7); *F:* 187.5 (59.0)
Bann et al., 2015	A	Actigraph GT3X	Hip	7	10	3	N/R	Higher-LPA	H/day	1041-1951 CPM	*M:* 12.1 (13.1); *F:* 12.1 (11.6)
								SB	H/day	<100 CPM	*M:* 663.1 (109.6); *F:* 634.3 (114.7)
								Steps	#/day	Device detected	*Sedentary:* 6178 (1381); *Moderate active:* 8624 (641); *Active:* 13524 (2553)
Barbat-Artigas et al., 2012	P/A	Suzuken Lifecorder PLUS NL2160	Waist	7	N/R	N/R	N/R	TPA	Min/day	≥3 MET (Subgroups – *Sedentary*: <7500; *Moderate active:* 7500-10000; *Active:* >10000)	*Sedentary*: 14.84 (9.36); *Moderate active:* 24.81 (15.15); *Active:* 50.06 (23.45)
Bartlett and Duggal, 2020	A	Actigraph GT3X	N/R	7	N/R	N/R	N/R	Steps (Active vs. Sedentary)	#/day	*Active:* 10500-15000; *Sedentary:* 1518-4580	*Active:* 12019 (1412); *Sedentary:* 3657 (777)
Bassey et al., 1988	A	N/R	Waist	7	N/R	N/R	N/R	Steps (*step score)*	#/day x 10^3	Device detected	*M:* 50 (37); *F:* 42 (28)
Bogucka et al., 2018	P	Onwalk 900 Geonaute	N/R	2	N/R	2	N/R	Steps	#/day	Device detected	*Dynapenic*: 5296 (2892); *Non-dynapenic:* 7259 (3849)
								MVPA	% wear time	≥1723 CPM	*MS:* 1.5 (0.02); *HC:* 4.2 (0.03)
							MS: 797.8 (97.8)	LPA	% wear time	1722-100 CPM	*MS:* 30.6 (0.09); *HC:* 33.0 (0.07)
Bollaert and Motl, 2019	A	Actigraph GT3X	N/R	7	N/R	4		SB	% wear time	<100 CPM	*MS:* 67.9 (0.09); *HC:* 62.8 (0.08)
							HC: 851.8 (79.3)	PA bouts	#/day	>2 min PA	*MS:* 12.4 (4.9); *HC:* 13.4 (3.7)
								PA bouts	Min/bout/day	>2 min PA	

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Table C3 (*continued*)

Author year	A/P	Name	Worn on	# days worn	Defined as minimum (h/day)	# valid days required	Wear time mean (SD) (min/day)	Reported measure(s)[a]	Units	Cut off values/definition	Mean (SD)
	Device and wearing protocol				Assessment of valid days			Physical activity and sedentary behavior			
											MS: 45.9 (29.5); *HC:* 43.4 (28.2)
								SB bouts	#/day	>2 min SB	*MS:* 15.2 (3.2); *HC:* 15.7 (3.1)
								SB bouts	Min/bout/day	>2 min SB	*MS:* 24.5 (7.3); *HC:* 22.9 (3.9)
								Long SB bouts	#/day	>30 min SB	*MS:* 5.9 (1.4); *HC:* 5.5 (1.9)
								Long SB bouts	Min/bout/day	>30 min SB	*MS:* 51.4 (8.2); *HC:* 47.8 (6.0)
				14				*Actigraph measures:* ΔSteps	#/day	Device detected	Baseline: 4284 (3533); 6-month FU: 3594 (3212); 12-month FU: 3533 (2930)
								ΔMVPA	Ratio	Ratio of moderate to. vigorous PA	Baseline: 8.8 (18.8); 6-month FU: 7.4 (17.4); 12-month FU: 6.1 (15.7)
								ΔVMU	#/day	Vectorial sum of activity counts in three orthogonal directions	Baseline: 374902.4 (265269); 6-month FU: 330420 (223152); 12-month FU: 336240 (214432)
Boutou et al., 2019	A	Actigraphy GT3X and Dynaport MiniMod (concurrent)	Hip and back	FU: 7	10	1	N/R	*Dynaport measures:* ΔSteps	#/day	Device detected	Baseline: 4690 (3708); 6-month FU: 4264 (3378); 12-month FU: 4359 (3425)
								ΔSteps (*Walking)*	Min/day	Device detected	Baseline: 59.1 (34.9); 6-month FU: 53.2 (34.4); 12-month FU: 56.9 (38.7)
								ΔMET	G	Metabolic equivalents	Baseline: 0.183 (0); 6-month FU: 0.183 (0); 12-month FU: 0.181 (0)
								ΔVMU	#/day	Vectorial sum of activity counts in three orthogonal directions	Baseline: 286039.6 (237721); 6-month FU: 265253.2 (218109); 12-month FU: 259447.4 (199472)
Carrasco Poyatos et al., 2016	A	Actigraph GT3X	Wrist	7	10	5	N/R	MVPA	CPM	≥500 CPM (Subgroups – *MPA group:* 500-760 CPM; *VPA group:* >760 CPM)	*MPA group:* 20.6 (1.6); *VPA group:* 22.6 (1.1)
Chastin et al., 2012	A	ActivPAL	Thigh	7	N/R	N/R	N/R	SB	H/day	Device detected (sitting posture)	*F:* 16.8 (1.6); *M:* 17.7 (1.8)
								SB break rate	#/sedentary h	N/R	*F:* 3.3 (0.4); *M:* 2.6 (0.8)
Chmelo et al., 2013	A	Kenz Lifecorder	Waist	7	N/R	N/R	N/R	Steps	#/day	Device detected	6209 (2554) 10.6 (8.9) 131 (39) 237 (124)
								MVPA	Min/day	≥ 3 MET	
								LPA	Min/day	<3	
								EE	Kcal/day	Device detected	
Cooper et al., 2015	A	Acitheart	Chest	7	6 h per quadrant of day	2	5.03 [4.8-5.2]	MVPA	Min/day	≥3 MET	*M:* 90.5 (64.9); *F:* 79.9 (54.9)
								SB	H/day	<1.5 MET	*M:* 17.4 (2.2); *F:* 17.3 (2.0)
								EE	Kj/kg/day	Device detected	*M:* 38.1 (15.7); *F:* 34.2 (13.3)
Davis et al., 2014	A	ActiGraph GT1M	Waist	7	10	5	14.4 (1.4) h/day	MVPA	Min/h	>1951 CPM	0.9 (1.3)
								SB	Min/h	0-99 CPM	42.8 (6.1)
								BST	#/h	Any transition from SB	5.0 (1.0)
de Melo et al., 2010	P	StepsCount SC-01	N/R	3	N/R	N/R	N/R	Steps	#/day	Device detected	5289 (4029)
de Melo et al., 2014	P	StepCount SC-01	N/R	3	N/R	N/R	N/R	Steps (medium vs. high)	Categorical #/day	≥3000-6500 vs. ≥ 6500 steps/day	5289 (4029)
Demeyer et al., 2019	A	SenseWear Pro Armband	Arm	7	70% of waking hours 8am-10pm	3	89 (9) % of day; 6 (1) days	ΔSteps (persistently active, decline,	Categorical #/day	Active at follow-up and baseline, declined at follow-up from baseline, inactive at follow-up and baseline	N/R

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Table C3 (*continued*)

Author year	Device and wearing protocol				Assessment of valid days			Physical activity and sedentary behavior			
	A/P	Name	Worn on	# days worn	Defined as minimum (h/day)	# valid days required	Wear time mean (SD) (min/day)	Reported measure(s)[a]	Units	Cut off values/definition	Mean (SD)
								persistently inactive)			
								Steps	#/day	Device detected	7362 (4589)
								MVPA	Min/day	>3 MET	52 [22-91]
								SB	Min/day	<1.5 MET	624 (118)
Distefano et al., 2018	A	SenseWear Pro Armband	Arm	7	85% day	N/R	N/R	Steps	#/day	Device detected	*Active:* 8459 (2991); *Sedentary:* 4883 (2683)
Dogra et al., 2017	A	Actical	Hip	7	10	4	N/R	BST	#/day	Transition from SB (<100 CPM) >1 min	44 (95% CI: 43, 45)
								Long SB bouts	% time/day	>20 min SB bouts	9 (95% CI: 8, 9)
Dohrn et al., 2020	A	ActivPAL 3	Thigh	7	10	4	852 (64)	SB	Min/day	Device detected (sitting posture)	512.1 (95% CI: 455.6, 571.7
								SB break rate	#/sedentary h	Sit to stand transition	5.1 (95% CI: 4.0, 6.4)
								SB bouts	Min/all SB bouts	Midpoint of cumulative distribution of all SB bout durations	30.1 (95% CI: 24.4, 39.1)
								Long SB bouts	Min	Longest sedentary bout	132.6 (95% CI: 106.4, 167.2)
Dos Santos et al., 2019	A	Actigraph GT3X	Waist	5	10	4	N/R	MVPA (sufficient vs. insufficient)	Min/day	≥ or <30 min MVPA (≥ 1041 CPM)	N/R
Duncan et al., 2016	P	Piezo Electric Pedometer New Lifestyles NL-2000	Waist	7	N/R	N/R	N/R	Steps (high, medium, low)	#/day	>7500, 5001-7500, 2501-5000 steps	N/R
Edholm et al., 2019	A	Actigraph GT3X	Waist	7	10	4	14.2 (1.0) h/day; 5.6 (6.0) days	Activity counts	#/min/day	Device detected	307 (128) 32 (26)
								MVPA	Min/day	>2020 CPM	
Foong et al., 2016	A	Actigraph GT1M	Waist	7	10	5	N/R	Activity counts	10,000/day	Device detected	*F:* 27.7 (12.5); *M:* 31.5 (14.3)
								VPA	10 min/day	≥6 MET	*F:* 0.5 (0.3); *M:* 1.2 (0.4)
								MVPA *(MPA)*	10 min/day	3-5.9 MET	*F:* 27.9 (22.5); *M:* 36.3 (26.7)
								LPA	10 min/day	1.5-2.9 MET	*F:* 226.7 (7.1); *M:* 227.1 (73.0)
								SB	10 min/day	<1.5 MET	*F:* 582.6 (89.0); *M:* 585.1 (99.5)
Gennuso et al., 2016	A	ActivPAL and Actigraph GT3X	Thigh and hip	7	10	3	N/R	SB	H/day	Device detected (sitting or lying posture)	*M:* 9.6 [8.7-11.1]; *F:* 9.3 [7.9-10.3]
								SB bouts	Min/day	Duration of SB bouts	*M:* 12.7 [10.7-16.0]; *F:* 10.7 [8.7-13.4]
								Long SB bouts (≥20 min)	H/day	Duration of ≥20 min SB bouts	*M:* 6.2 [5.2-7.1]; *F:* 5.7 [4.7-6.9]
								≥40 min SB bouts	H/day	Duration of ≥40 min SB bouts	*M:* 3.7 [3.1-5.0]; *F:* 3.8 [3.3-4.5]
								≥60 min SB bouts	H/day	Duration of ≥60 min SB bouts	*M:* 2.4 [1.8-3.1]; *F:* 2.4 [1.6-3.3]
								SB break rate	#/sedentary h	Disruption of SB	*M:* 4.7 [3.8-5.6]; *F:* 5.5 [4.5-6.9]
Gerdhem et al., 2007	A	MTI AM 71256	Hip	7	8	5	N/R	Activity counts	#/min/day	Device detected	18 [11-23]
								MVPA	Min/day	>1952 CPM	13 [6-23]
Hall et al., 2016	A	ActiGraph GT3X or GT3X+	Waist	7	10	4	N/R	Steps	#/day	Device detected	*60-69y*: 6311.0 (2668.4);*70-79y*: 5275.5 (2717.0); *80-90+y*: 3591.1 (2133.8)
								MVPA	Min/day	N/R	

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Table C3 (*continued*)

Author year	Device and wearing protocol				Assessment of valid days			Physical activity and sedentary behavior			
	A/P	Name	Worn on	# days worn	Defined as minimum (h/day)	# valid days required	Wear time mean (SD) (min/day)	Reported measure(s)[a]	Units	Cut off values/definition	Mean (SD)
											60-69y: 33.7 (24.8); *70-79y*: 24.7 (25.8); *80-90+y*: 12.3 (15.4) 20.9
								SB	% time/day	N/R	*60-69*: 96.0 (2.9); *70-79*: 97.1 (2.9); *80-90+*: 98.6* (1.8) 97.5
Harada et al., 2016	A	ACOS GT40-020	N/R	14	10	8	N/R	Steps	#/day	Device detected	6654.6 (2958.8)
Hartley et al., 2018	A	Gulf Coast Data Concepts x16-1c	Hip	7	10	N/R	N/R	Activity counts (low impact, medium impact, high impact)	#/impact-band/day	0.5 ≤ g<1.0, 1.0 ≤ g<1.5, ≥1.5g	11457.8 [5779.1-18827.9], 452.6 [183.7-950.9], 51.8 [23.0-124.2]
Hasegawa et al., 2018	P	Misfit Shine 2	Hip	7	N/R	N/R	N/R	Steps	#/day	Device detected	6500 (3200)
Hernandes et al., 2013	P	Yamax SW-200 Digiwalker	Waist	7	12	8	N/R	Steps	#/day	Device detected	*Exercise:* 8314 [5971-10060]; *Non-exercise*: 6250 [4346-8207]
Hernández et al., 2017	A	Actigraph GT3X+	Hip	8	8	5	N/R	Steps	#/day	Device detected	8105.9 (3851.2)
								TPA	Min/day	Device detected	N/R
								MVPA *(MPA)*	Min/day	1952-5724 CPM	39.1 (33.9)
								LPA	Min/day	100-1951 CPM	227.2 (89.9)
								SB	Min/day	<100 CPM	578.6 (86.2)
Hopkins, 2019	A	Actigraph GT1M	N/R	7	10	4	N/R	MVPA (Meeting vs. not meeting guidelines)	Dichotomous min/day	≥ or <150 min MVPA (>2020 CPM)	N/R
Iijima et al., 2017	P	N/R	Leg	14	N/R	10	N/R	Steps	#/day	Device detected (Subgroups - *Basal activity:* <2500 steps; *Limited activity:* 2500-4999 steps; *Low active:* 5000-7499 steps; *Physically active:* ≥7500 steps)	*Basal activity:* 1711 (591); *Limited activity:* 3718 (754); *Low active:* 5808 (701); *Physically active:* 9858 (2132)
Ikenaga et al., 2014		ACCtri Actimarker EW4800 × 2 (concurrent)	N/R	10	300 steps/day or 10 min/day of activity >2 MET	4	N/R	Steps	#/day	Device detected	6523 (3797)
								MPA	Min/day	3.0-5.9 MET	34.3 (27.0)
								LPA	Min/day	1.1-2.9 MET	563.5 (125.4)
								SB	Min/day	<1.1 MET	842.1 (129.8)
Iwakura et al., 2016	A	Lifecorder	Waist	N/R	N/R	5 (Mon-Fri)		Steps	#/day	Device detected	4546 (2992)
								MVPA	Min/day	>3 MET	13.9 (14.0)
Jantunen et al., 2017	A	Sense Wear Pro 3	Arm	10	10	4 (Mon-Fri) + 1 (Sat-Sun)	1436.8 (6.0)	MET	H/day	Device detected	1779.6 (298.5)
Jeong et al., 2019	A	Fitbit charge 2	Wrist	7	10	4	N/R	Steps	#/day	Device detected	9907.6 (3641.8)
Johnson et al., 2016	A	Actigraph GT1M	Hip	7	10	5	843.37 (75.587)	VPA	Min/day	≥6 MET	0.390 (1.318)
								MVPA *(MPA)*	Min/day	3-5.9 MET	31.490 (21.923)
								LPA	Min/day	1.5-2.9 MET	228.560 (69.292)
								SB	Min/day	<1.5 MET	581.670 (93.844)
Kawagoshi et al., 2013	A	A-MES	Thigh and chest	7	12	2	4 (2) days	Steps *(Walking)*	Min/day	Standing + vertical acceleration	118 (72)
								Standing	Min/day	Trunk and thigh sensor vertical (not incl. walking)	79 (48)
									Min/day	Walking ≥2 km/h	36 (35)

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Table C3 (*continued*)

Author year	Device and wearing protocol				Assessment of valid days			Physical activity and sedentary behavior			
	A/P	Name	Worn on	# days worn	Defined as minimum (h/day)	# valid days required	Wear time mean (SD) (min/day)	Reported measure(s)[a]	Units	Cut off values/definition	Mean (SD)
								MVPA (*Fast walking)*			
								LPA (*Slow walking)*	Min/day	Walking <2 km/h	69 (30)
								SB (*Sitting)*	Min/day	Trunk sensor vertical, thigh sensor non-vertical	417 (116)
								Lying	Min/day	Thigh sensor non-vertical	107 (105)
Keevil et al., 2016	A	Actigraph GT1M	Hip	7	10	4	*M:* 882 (70.5); *F:* 864 (64.7)	MVPA	Min/day	≥1952 CPM	*M:* 39 (24.8); *F:* 35 (21.6)
								SB	H/day	<100 CPM	*M:* 701 (76.5); *F:* 669 (71.7)
Kim, 2015	A	Actigraph GT3X+	Wrist	7	N/R	5	N/R	Activity counts	#/min/day	Device detected	1771.8 (520.6)
Kim et al., 2015	A	Actigraph GT3X	Hip	10	10	5 (incl. 1 Sat-Sun)	924.6 (108.6)	Activity counts	#/min/day	Device detected	174.7 (74.8)
								MVPA	% time/day	≥1952 CPM	2.7 (1.6)
								LPA	% time/day	1951-100 CPM	12.6 (1.6)
								SB	%. time/day	<100 CPM	84.6 (4.9)
								Long SB bouts	Min/day	Duration >30 min SB bouts	53.9 (50.9)
Lai et al., 2020	A	Actigraph wGT3X-BT	Waist	7	10	4 (incl. 1 Sat-Sun)	15.4 (SD N/R) h/day	MVPA (Meeting vs. not meeting guidelines)	Dichotomous min/day	≥30 min/day MVPA (>2020 CPM)	24.6 (23.2)
Lee et al., 2015	A	Actigraph GT1M	Hip	7	10	4	14.8 (SD N/R) h/day	SB	H/day	<100 CPM	9.8 (1.5)
Lerma et al., 2018	A	Actigraph GT3X	Hip	7	N/R	N/R	844.8 (75.8)	MVPA	Min/day	≥1952 CPM	25.0 (20.9)
								LPA	Min/day	100-1951 CPM	283.1 (73.3)
								SB	Min/day	<100 CPM	536 (75.7)
Liao et al., 2018	A	Active Style Pro HJA-350IT	Hip	7	10	4 (incl. 1 Sat-Sun)	900.9 (86.4)	SB	Min/day	<1.5 METs	524.9 (111.7)
								Break rate	#/sedentary h	Non-SB bout b/t two SB bouts	7.6 (2.9)
								Long SB bouts	#/day	# ≥30 min SB bouts	4.4 (1.9)
								Long SB bouts	Min/day	Duration ≥30 min SB bouts	233.0 (118.5)
Lohne-Seiler et al., 2016	A	ActiGraph GT1M	Hip	7	10	1	6.6 (1.4) days; 14.0 (1.2) h/day	Steps	#/day	Device detected	N/R
Mador et al., 2011	A	Actigraph GT1M	N/R	7	10	4	12.7 (2.1) h/day	VMU	#/min/day	Device detected	116.5 (62.7)
Master et al., 2018	A	Actigraph GT1M	Hip	7	10	4	N/R	Steps	#/day	Device detected	6166 (2924)
Matkovic et al., 2020	A	StepWatch Activity Monitor	Ankle	7	8	N/R	N/R	Steps	#/day	Device detected	8059 (4757)
McDermott et al., 2002	A	Caltrac	Waist	7	N/R	N/R	N/R	Accelerations (standardized)	#/day	Device detected normalized for age, sex height and weight	897.5 (533.4)
McGregor et al., 2018	A	Actical	Hip	7	10	4	N/R	MVPA	Log-ratio	≥1535 CPM	N/R
								LPA	Log-ratio	100-1534 CPM	N/R
								SB	Log-ratio	<100 CPM	N/R
								Steps	#/day	Device detected	
Meier and Lee, 2020	P	Omoron HJ-321	Waist	7	N/R	N/R	N/R	Steps (high, medium, low)	#/day	≥5000, 2500-4999, <2500	4943 (2632)
Monteiro et al., 2019	A	Actigraph GT1M	Hip	7	8	3 (Mon-Fri)	N/R	Activity counts (terciles)	#/min/day	T1: ≤507.75 CPM, T2: 507.75-752.08 CPM, T3: ≥752.08 CPM	N/R
Morie et al., 2010	A	Actigraph	Hip	7	N/R	5	6.6 (0.09) days	Activity counts	#/min/day x 10^{-5}	Device detected	12.2 (7.0)
Nagai et al., 2018	A	Actiband	Wrist	14	10	4	1015 (74)	MVPA	Min/day	≥3 MET	42 (34)
								LPA SB	Min/day	1.5-2.9 MET	463 (150)
									Min/day	<1.5 MET	510 (170)

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Table C3 (*continued*)

Author year	Device and wearing protocol				Assessment of valid days			Physical activity and sedentary behavior			
	A/ P	Name	Worn on	# days worn	Defined as minimum (h/day)	# valid days required	Wear time mean (SD) (min/day)	Reported measure(s)[a]	Units	Cut off values/definition	Mean (SD)
Nawrocka et al., 2017	A	Actigraph GT3X	Waist	7	10	N/R	N/R	MVPA (Meeting vs. not meeting guidelines)	Dichotomous min/day	≥150 min MPA (2020-5998 CPM) or ≥75 min VPA (>599 CPM) or equivalent combination of MVPA	N/R
Nawrocka et al., 2019	A	Actigraph GT3X	Waist	7	10	N/R	N/R	MVPA (Meeting vs. not meeting guidelines)	Dichotomous min/day	≥150 min MPA (2020-5998 CPM) or ≥75 min VPA (>599 CPM) or equivalent combination of MVPA	N/R
Nicolai et al., 2010	A	Physiolog BioAGM	Chest	7	N/R	N/R	N/R	Steps (*Walking)*	Min/day	≥3 consecutive steps	1.45 (0.07)
								TPA (*Time on feet)*	Min/day	Upright standing <3 steps + walking	5.01 (0.18)
Ofei-Doodoo et al., 2018	A	Kenz Lifecorder	Waist	14	N/R	N/R	N/R	MVPA	Min/day	Accelerometer intensity 4-6 (corresponds to 4-6 MET)	*≥30:00 min MVPA:* 49:42 {31:24-2:17:07}; *20:00-29:59 min MVPA:* 25:16 {20:00-29:59}; *10:00-19:59 min MVPA:* 14:51 {10:18-19:43}; *0:00-9:59 min MVPA:* 3:33 {0:02-9:58}
Orwoll et al., 2019	A	SenseWear Pro Armband	Arm	7	N/R	90% of time + 1 (Sat-Sun)	N/R	TPA (*≥LPA)*	Min/day	≥1.51 MET	*No falls:* 160.8 (88.2); *One fall:* 156.4 (89.9); *>Two falls:* 141.9 (89.1)
								MVPA (*≥MPA)*	Min/day	≥3 MET	*No falls:* 90.0 (61.5); *One fall:* 88.0 (62.0); *≥Two falls:* 77.8 (60.6)
Osuka et al., 2015	A	Kenz Lifecorder	Hip	7	10	5	875.3 (92.4)	MVPA	Min/day	≥3.6 MET	17.6 (15.3)
								LPA	Min/day	1.8-2.9 MET	57.1 (22.7)
								Steps	#/day	Device detected	7567.5 (3316.8)
Park et al., 2018	A	Active style Pro HJA-350IT	Waist	14	N/R	>3 (Mon-Fri) + 1 (Sat-Sun)	N/R	TPA	Min/day	≥0.9 MET	807.3 (69.5)
								VPA MVPA	Min/day	≥6.0 MET	0.4 (1.6)
								MPA	Min/day	≥3.0 MET	65.9 (29.7)
								LPA	Min/day	3-5.9 MET	65.4 (29.7)
								SB	Min/day	1.5-2.9 MET	354.1 (71.7)
									Min/day	0.9-1.5 MET	388.9 (81.3)
Perkin et al., 2018	A	Actiheart	Chest	6	N/R	N/R	N/R	MVPA	Min/day	≥3.2 MET	103 (49)
								SB	Min/day	≤1.5 MET	1058 (112)
								EE *(PAL)*	None	EE/basal metabolic rate	1.59 (0.17)
Pitta et al., 2005	A	DynaPort Activity Monitor	Waist and leg sensor	5	12	2	N/R	Steps (*Walking)*	Min/day	Device detected	44 (26)
								TPA *(Standing)*	Min/day	Device detected (not incl. walking)	191 (99)
Puthoff et al., 2008	A	AMP 331	Ankle	6	8	6	N/R	Steps	#/day	Device detected	6384.4 (2370.8)
Rapp et al., 2012	A	ActivPAL	Thigh	7	24	>3 (Mon-Fri) +1 Sun	N/R	Steps *(Walking)*	Min/day	Device detected	*M:* 104.8 (41.0); *F:* 103.0 (39.4)
Rausch-Osthoff et al., 2014	A	SenseWearPro Armband	Arm	7	N/R	N/R	N/R	Steps	#/day	Device detected	4097 (2325)
								EE	Kcal/day	Device detected	2222 (467)
								EE *(PAL)*	None	Total EE/sleep EE	1.44 (0.16)
								MET	Kcal/h/kg	Device detected	30.3 (4.7)
Rava et al., 2018	A	Actigraph	Hip	7	10	4	N/R	VPA	Min/day	≥ 5725 CPM	1.5 (6.1)
								MVPA	Min/day	≥1954 CPM	56.2 (29.6)
								MPA	Min/day	1952- 5724 CPM	54.7 (29.1)

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Table C3 (*continued*)

Author year	Device and wearing protocol				Assessment of valid days			Physical activity and sedentary behavior			
	A/P	Name	Worn on	# days worn	Defined as minimum (h/day)	# valid days required	Wear time mean (SD) (min/day)	Reported measure(s)[a]	Units	Cut off values/definition	Mean (SD)
Reid et al., 2018	A	ActivPAL 3	Thigh	7	10 (or >80% of waking hours)	N/R	N/R	LPA	Min/day	100-1951 CPM	261.0 (69.7)
								SB	Min/day	<100 CPM	605.5 (106.5)
								SB	H/day	Device detecting (sitting + lying posture)	9.7 (1.8)
								BST	10/day		47.8 (12.4)
								Steps	#/day	Device detected	7327 (2507)
Rojer et al., 2018	A	DynaPort Move Monitor	Waist	7	18	4	6.9 [6.8-7.0] h/day	TPA	Min/day	Device detecting (standing + locomotion)	256.7 (67.2)
								SB	H/day	Device detecting (sitting + lying)	19.0 (1.2)
								PA bouts	#/day	N/R	1407 (426)
								PA bouts	s/bout/day	N/R	11.3 (2.2)
								SB bouts	#/day	N/R	132 [111-160]
								SB bouts	Min/bout/day	N/R	8.9 (2.8)
Rosenberg et al., 2015	A	Actigraph GT3X+	Hip	6	10	1	5.7 (1.48) days; 13.6 (1.3) h/day	SB	H/day	<100 CPM	8.6 (1.0)
Rowlands et al., 2018	A	GeneActiv	Wrist	7	16	3	N/R	MVPA	Min/day	Acceleration >125mg-force	42.2 (32.8)
								Accelerations	Mg-force	Device detected	22.1 (7.5)
								Intensity gradient	N/R	Regression line from log-log plot of intensity (x) and minutes accumulated (y)	3.11 (0.26)
								PA bouts *(MVPA bouts)*	Min/day	Acceleration >100mg-force accumulated in >10 min bouts	9.3 (20.4)
Safeek et al., 2018	A	Actigraph GT3X	Waist	7	10	4	7 [1.00] days; 15 (SD N/R) h/day	Steps	#/day	Device detected	3411.89 [4612.81]
								MVPA	Min/day	≥2020 CPM	5.00 [9.13]
								LPA	H/day	100-2019 CPM	3.69 [2.72]
								SB	H/day	<100 CPM	10.82 [3.27]
								EE	Kcal/day	Device detected	254.86 [345.58]
Sánchez-Sánchez et al., 2019	A	ActiTrainer	Hip	7	8	4	84.39 (16.03) h	Activity counts	#/day	Device detected	409365.62 (180677.01)
								MVPA	H/day	≥3 MET	1.02 (0.78)
								LPA	H/day	1-.5-2.99 MET	5.01 (1.5)
								SB	H/day	<1.5 MET	6.98 (1.62)
Santos et al., 2012	A	Actigraph GT1M	Hip	4	10	3 (incl. 1 Sat-Sun)	819.6 (87.5)	MVPA	Min/day	≥2020 CPM	26.0 (24.1)
								SB	Min/day	<100 CPM	579.9 (106.3
Sardinha et al., 2015	A	ActiGraph GT1M	Hip	N/R	10	3 (incl. 1 Sat-Sun)	N/R	BST	#/day	Any interruption in SB defined as >100 CPM	78.9 (16.0)
Scott et al., 2020	A	Actigraph GT3X	Hip	7	10	4	*Non-sarcopenic:* 91.8 (17.7) h/week; *Sarcopenic:* 89.4 (19.4) h/week	MVPA	H/week	≥1952 CPM	*Non-sarcopenic:* 3.7 (3.0); *Sarcopenic:* 2.4 (2.5)
								LPA	H/week	100-1951	*Non-sarcopenic:* 29.3 (9.5); *Sarcopenic:* 27.5 (10.3)
								SB	H/week	<100 CPM	*Non-sarcopenic:* 58.7 (12.8); *Sarcopenic:*59.5 (15.3)
Scott et al., 2011	P	Baseline: Omron HJ-003 & HJ-102	Leg	7	8	5	6.8 (0.2) days, 12.27 (0.17) h/day	Steps (*baseline*)	#/day x 10^3	Device detected	Baseline: 9002.7 (3250.4); 6 month FU: 7688.6 (3148.2)
		6-month follow-up: Yamax SW-200						Steps (*habitual*)	#/day x 10^3	Mean of 3 time points (baseline, baseline+6 months, follow-up)	
Scott et al., 2009	P	Omron HJ-003 or HJ-102	Waist	7	8	5	Removal time: 0.44 (0.48) h/day	Steps	#/day	Device detected	9622 (4004)
Semanik et al., 2015	A	Actigraph GT1M	Hip	7	10	4	14.9 (SD N/R) h/day	SB	H/day	<100 CPM	9.8 (1.5)

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Table C3 (*continued*)

Author year	A/P	Name	Worn on	# days worn	Defined as minimum (h/day)	# valid days required	Wear time mean (SD) (min/day)	Reported measure(s)[a]	Units	Cut off values/definition	Mean (SD)
	Device and wearing protocol				Assessment of valid days			Physical activity and sedentary behavior			
Silva et al., 2019	A	Actigraph GT1M	Back	5	10	2 (Mon-Fri) + 1 (Sat-Sun)		MVPA	Min/day	≥2020 CPM	33.46 (27.25)
								LPA	Min/day	100-2019 CPM	291.16 (91.20)
								SB	Min/day	<100 CPM	458.10 (78.68)
Spartano et al., 2019	A	Actical 198-0200-00	Hip	8	10	4	749 (71)	Steps	#/day	Device detected MVPA:	6927 (3678)
								MVPA	Min/day	>1486 CPM	19 (22)
								SB	% wear time	<200 CPM	84.3 (6.3)
Tang et al., 2015	A	Actigraph	Wrist	N/R	N/R	N/R	15.5 [9-25.3]	Activity counts	#/day	Device detected for 10 h of day with highest activity	966,131 [720529-1267931]
Trayers et al., 2014	A	Actigraph GT1M	N/R	7	10	5	N/R	Steps (low vs. high)	#/day	Device detected (lowest 1/3 vs. highest 2/3)	181 (117)
								Activity counts (low vs. high)	#/min/day	Device detected (lowest 1/3 vs. highest 2/3)	4456 (2478)
								MVPA (low vs. high)	Min/day	>1952 CPM (lowest 1/3 vs. highest 2/3)	18.5 (20.2)
Van Gestel et al., 2012	A	SenseWear Pro	Arm	7	N/R	N/R	N/R	Steps	#/day	Device detected	5273 (3319)
Van Lummel et al., 2016	A	Dynaport	Lower back	7	N/R	N/R	6.8 (N/R) days; 23.2 (SD N/R) h/day	TPA *(standing)*	H/day	Device detected (standing posture)	2.1 (0.9)
								# PA bouts *(locomotion periods)*	#/day	N/R	297.3 (150.7)
								SB bout *(sitting periods)*	Min/bout/day	Device detected (sitting posture)	5.7 (3.0)
van Oeijen et al., 2020	P	Lifestyles DigiWalker Step Counter	N/R	7	N/R	N/R	N/R	Steps	#/day	Device detected	Baseline: 5771.14 [4403.0]; 4y FU: 4493.93 [4203.46]
Van Sloten et al., 2011	P	Piezo-electric New Lifestyle 2000	Waist	7	N/R	N/R	14.9 (1.1) h/day	Steps	#/day	Device detected	6429 [45170-8573]
Walker et al., 2008	A	Actiwatch	Waist and thigh	3	N/R	N/R	For evaluation: 15.7 (0.2)	TPA *(time mobile)*	% time/day	% of 30 s epochs where device level ≥1	50.0 (2.7)
Ward et al., 2014	A	Actigraph single-axis	Hip	7	10	5	N/R	Activity counts	#/min/day	Device detected	*F:* 2473.03 (111.50; *M:* 319.23 (131.0)
								MVPA	Min/week	>3 MET	*F:* 79.56 (96.82); *M:* 95.13 (91.90)
Waschki et al., 2012	A	SenseWear Armband	Arm	8	22	5	*Maastricht*: 142 h 17 min *Liverpool:* 141 h 1 min; *London:* 142 h 24 min	Steps	#/day	Device detected	
								EE *(PAL)*	None	EE/sleeping metabolic rate (device detected)	4725 (3212) 1.45 (0.20)
Watz et al., 2008	A	SenseWear Armband	Arm	5-6	22.5	5	N/R	Steps	#/day	Device detected	5882 (3684)
								EE *(PAL)*	None	EE/sleeping metabolic rate (device detected)	1.50 (0.28)
Westbury et al., 2018	A	GENEActiv	Wrist	7	N/R	7	N/R	TPA	Min/day	≥ 40mg-force	*M:* 137.8 [81.7-217.2]); *F:* 186.0 [122.1-240.4]
								MVPA	Min/day	≥100mg-force	*M:* 14.3 [1.8-30.2]; *F:* 9.5 [2.1-18.6]
Wickerson et al., 2013	A	Actigraph GT3X	Hip	7	8	N/R	4.5 (1.6) h/day; 6.6 (1.0) days	Accelerations	Mg-force	Device detected	*M:* 23.9 (7.6); *F:* 25.5 (6.8)
								Steps,	#/day	Device detected	2736 (1612)
								MVPA *(MPA)*	Min/day	3-6 MET	3.6 [1.5-7.7]
Winberg et al., 2015	P	Yamax SW 200		3	N/R	N/R	N/R	Steps	#/day	Device detected	6270 (3120)

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Table C3 (*continued*)

	Device and wearing protocol				Assessment of valid days			Physical activity and sedentary behavior			
Author year	A/P	Name	Worn on	# days worn	Defined as minimum (h/day)	# valid days required	Wear time mean (SD) (min/day)	Reported measure(s)[a]	Units	Cut off values/definition	Mean (SD)
Yamada et al., 2011	P	Yamax Power Walker EX-510	Lower back Leg	14	N/R	N/R	N/R	Steps	#/day	Device detected	*Non-frail:* 4414.4 (2726.3); *Frail:* 1585.0 (1012.6)
Yasunaga et al., 2017	A	Active style Pro HJA-350IT	Waist	7	10	4 (incl. 1 Sat-Sun)	901.1 (87.5); 7.2 (SD N/R) days	MVPA LPA SB	Min/day Min/day Min/day	≥3 MET >1.5 - <3 MET ≤1.5 MET	50.2 (33.5) 328.7 (101.4) 522.7 (113.4)
Yoshida et al., 2010	A	Active style Pro HJA	N/R	15	500 min/day	7	N/R	Steps TPA MPA LPA	#/day Min/day Min/day Min/day	Device detected Device detected Device level 3-6 (~3-6 MET) Device level 1-2 (~<3 MET)	*HFG:* 2416 (2055); *LFG:* 1275 (1313) *HFG:* 36.8 (24.0); *LFG:* 24.4 (18.8) N/R N/R
Yuki et al., 2019	A	Suzken Lifecorder	N/R	7	10	N/R	N/R	Steps LPA MVPA	Min/day Min/day Min/day		7204.1 (3500.3) 55.5 (22.8) 20.4 (19.2)

Mean (standard deviation (SD)) of wear time and physical activity/sedentary behavior are presented unless otherwise reported as median [interquartile range], or mean {range}. *Subgroups* for stratified results are presented in italics. Underlined articles have a longitudinal design.

A = accelerometer, p = pedometer, PA = physical activity, SB = sedentary behavior, N/R = not reported, TPA = total physical activity, MPA = moderate physical activity, VPA = vigorous physical activity, MVPA = moderate to vigorous physical activity, LPA = light physical activity, SB = sedentary behavior, EE = energy expenditure, PAL = physical activity units, BST = breaks in sedentary time, Δ=change, MET = metabolic equivalent of tasks, VMU = vector magnitude units, min = minutes, h = hours, CPM = counts per minutes, #=number, mg-force = miligrams-force (force of earth gravity acting on one milligram), Mon = Monday, Fri = Friday, Sat = Saturday, Sun = Sunday, vs = versus (compared to), MIDEEA = Intelligent Device for Energy Expenditure and Activity, HFG = high functioning group, LFG = low functioning group.

[a] Reported measures of PA and SB were classified as either steps, activity counts, TPA, MVPA, LPA, SB, PA bouts, SB bouts, long SB bouts, BST, SB break rate, accelerations, VMU, intensity gradient, EE; further details of reported measures are provided in parentheses and italic font when measures were originally described otherwise but were classified as one into one of the aforementioned categories.

Table C4
Ascertainment and measurement characteristics of measures of upper body and lower body muscle strength and muscle power.

Author year	Device/equipment	Definition and protocol	Measure type	Reported measure (s)	Units	Mean (SD)[a]
Abe 2015	Biodex System 3 Dynamometer	MVC isometric KES, 2-3 attempts, max/ weight used for analysis	LB MS	KES/weight	Kg/ nm	105 (25)
	Toe-Grasp T.K.K. 3361 Dynamometer	Max toe grasping strength, 3 attempts for each foot, max of each foot averaged used	LB MS	Toe grasping/ weight	Kg/kg	13.4 (3.5)
Abe et al., 2012	Bidoex System 3 Dynamometer	MVC isometric strength of knee flexors and extensors, 2-3 attempts, max used for analysis	LB MS	KES	Nm	105 (25)
			LB MS	Knee flexion strength	Nm	45 (9)
Aggio et al., 2016	Jamar Hydraulic Hand Dynamometer	HGS, 3 attempts for each hand, max used	UB MS	HGS	Kg	*Non-sarcopenia:* 32.3 (9.9); *Sarcopenia:* 28.7 (10.1); *Severe sarcopenia:* 22.2 (6.1)
Alcazar et al., 2018	Leg press E	Leg press 1RM, progressive reps increasing by 10 kg, force-velocity evaluation to determine max force (strength) and max power for analysis	LB MS	Leg press strength	N	N/R
			LB MP	Leg press power	W	N/R
			LB MP	Leg press power/ weight	W/kg	N/R
Alzahrani et al., 2012	Handheld Dynamometer N/R	MVC KES, 2 attempts, max used for analysis	LB MS	KES	N	116 (52)
Andersson et al., 2013	Steve Strong Dynamometer	MVC isometric KES strength, 3 attempts, recorded in N, max used and converted into kg	LB MS	KES	Kg	31.3 (11.2)
André et al., 2018	N/A	Calf raise (heel rise) senior test, # of calf raises (heel rises) in 30 s, high: ≥38 and low: <38	LB MP	Calf raise (High vs. low)	#/30 s	37.8 (13.4)
André et al., 2016	N/A	Calf raise (heel rise) senior test, # of calf raises (heel rises) in 30 s	LB MP	Calf raise	#/30 s	31.79 (7.01)
Aoyagi et al., 2009	Smedley Dynamometer ES-100	HGS, 2 attempts with dominant hand, max used for analysis	UB MS	HGS	N	262 (83)
	μTas Dynamometer MF-01	Isometric knee extension torque, 2 attempts, max used for analysis	LB MS	Knee extension torque	Nm/ kg	1.34 (0.37)
Ashe et al., 2008	Keiser Air-pressured Digital Resistance Leg Press Machine	1RM KES, progressive reps increasing by 10%, max used for analysis	LB MS	Leg press strength	Kg	325 (66)
		Bilateral leg extension, reps at 40%, 50%, 60%, 70%, 80%, and 90% of individual's 1RM, max power used for analysis	LB MP	Leg press power	W	656 (193)
Ashe et al., 2007	Jamar JLW Dynamometer	HGS, 3 attempts with left hand, mean used	UB MS	HGS	Kg	24.2 (10.9)
	Nicolas MMT 11560 handheld Dynamometer	KES, 3 attempts with left leg, mean normalized to weight used for analysis	LB MS	KES	Kg	18.2 (7.3)
Aubertin-Leheudre et al., 2017	Jamar Dynamometer	HGS, 2 attempts, max used, non-dynapenic: ≥20 kg for F and ≥32 kg for M, dynapenic: ≤19.9 for F and ≤31.9 kg for M	UB BS	HGS (dynapenic vs. non-dynapenic)	Kg	*Non-obese non-dynapenic:* 28.9 (9.1); *Non-obsese dynapenic:* 18.7 (6.5); *Obese non-dynapenic:* 29.7 (9.0); *Obese dynapenic:* 18.4 (5.8)
Balducci et al., 2017	Digimax Mechatronic GmbH (strain gauge tensiometer) and Shoulder Press/Lat Pull OR Leg Press, Easy Line Technogym	MVC at shoulder press, 3 attempts, max used	UB MS	Shoulder press strength	Nm	254.8 (92.5)
		MVC at leg press, 3 attempts, max used	LB MS	Leg press strength	Nm	161.1 (60.4)
Bann et al., 2015	Jamar	HGS, 2 attempts, dominant arm max used	UB MS	HGS	Kg	*M:* 31.7 (10.2); *F:* 19.9 (6.3)
Barbat-Artigas et al., 2012	Lafyette Instrument Hand Dynamometer	HGS, 3 attempts with each hand, maxed used	UB MS	HGS	Kg	*Sedentary:* 28.4 (3.9); *Moderately active:* 27.3 (4.3); *Actively:* 28.0 (4.4)
	Kim Com 5000 Dynamometer	Isometric KES, 3 attempts, max used	LB MS	KES	N	*Sedentary:* 438 (80); *Moderately active:* 400 (69); *Active:* 464 (116)
	N/A	# chair stands completed in 20 s	LB MP	20 s CST	#/20 s	*Sedentary:* 13 (3); *Moderately actively:* 11 (3); *Actively:* 13 (3)
Bartlett and Duggal, 2020	N/R	N/R	UB MS	HGS	Kg	*Sedentary:* 29.02 (8.34); *Active:* 30.64 (10.11)
Bassey et al., 1988	Bourdon Tube	MVC isometric plantar flexor strength of the triceps surae, 3 attempts, max used	LB MS	Calf strength	N	*M:* 1128 (206); *F:* 873 (177)
Bogucka et al., 2018	Hydraulic Dynamometer	HGS, two attempts for each arm, mean for each hand calculated and mean of both hands used	UB MS	HGS	Kg	*Dynapenic:* 17.55 (2.6); *Non-dynapenic:* 25.9 (4.6)
Bollaert and Motl, 2019	N/A	Time to complete 5 chair stands	LB MP	5x CST (0-4)	Points	*MS:* 2.0 (1.3); *HC:* 3.5 (0.7)
Boutou et al., 2019	N/R	MVC KES (quadriceps) N/R	LB MS	KES	Kg	Baseline: 33.4 (32.4)
Carrasco Poyatos et al., 2016	Takei Dynamometer TKK 5001	HGS, 3 attempts with each hand, mean of max in each hand used	UB MS	HGS	Kg	21.22 (1.7)
Chastin et al., 2012	Nottingham Power Rig	N/R	LB MP	Leg extension power	N/R	N/R

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Table C4 (*continued*)

Author year	Device/equipment	Definition and protocol	Measure type	Reported measure (s)	Units	Mean (SD)[a]
Chmelo et al., 2013	Kin Com 125E Isokinetic Dynamometer	Concentric KES	LB MS	KES	N	229 (85)
Cooper et al., 2015	Nottingham Electric Dynamometer	HGS, 3 attempts with each hand, max used	UB MS LB MP	HGS	Kg	*M:* 46.4 (11.5); *F:* 27.0 (7.5)
	N/A	Time to complete 10 chair stands		10x CST	#/min	*M:* 26.2 (7.3); *F:* 24.9 (7.3)
Davis et al., 2014	N/A	Time to complete 5 chair stands, >16.70s = 0 points, 13.70-16.69s = 1 point, 11.20-13.69s = 3 points, <11.19s = 4 points	LB MP	5x CST (0-4)	Points	2.7 (1.3)
de Melo et al., 2010	N/A	# chair stands completed in 30 s	LB MP	30 s CST	#/30 s	19.4 (5.4)
de Melo et al., 2014	N/A	# of full flexion and extension of the elbow without moving the shoulder (arm curls) using dumbbells (*F:* 5 pounds, *M:*8 pounds) completed in 30 s	UB MP	Arm Curl	#/30 s	15.2 (3.7)
	N/A	# chair stands completed in 30 s	LB MP	30 s CST	#/30 s	10.4 (5.4)
Demeyer et al., 2019	N/R	ΔHGS, non-dominant hand, measured at baseline and after 2.6 (SD: 0.6) years	UB MS	Δ HGS	N	Baseline: 295 (87); Follow up: 272 (84); Decline per year: 7.84 (23)
Distefano et al., 2018	Standard weight stack	1RM KES, left leg, progressive reps increasing by 10%, max used.	LB MS	KES	Kg	*Active:* 35.6 (2.5); *Sedentary:* 31.9 (1.7)
	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	N/R
Dogra et al., 2017	Smedley Dynamometer	HGS, two attempts with each hand, sum of max from each hand used	UB MS	HGS	Kg	64 (95% CI: 62, 66)
Dohrn et al., 2020	N/A	Ability to complete 5 chair stands	LB MP	5x CST (able vs. non-able)	None	N/R
Dos Santos et al., 2019	Camry EH101 Digital Dynamometer	HGS, two attempts with dominant hand, max from each hand used, *M:* > or < 30 kg, *F:* > or < 20kg	UB MS	HGS (low vs. high)	Kg	N/R
Duncan et al., 2016	N/A	# of full flexion and extension of the elbow (arm curls) with dumbbells *F:* 5 pounds and *M:*8 pounds completed in 30 s	UB MP	Arm curl	#/30 s	Low: 13.7 (SE = 0.61; Medi*um:* 15.8 (SE = 0.43); High: 18.4 (0.41)
	N/A	# chair stands completed in 30 s	LB MP	30 s CST	#/30 s	Low: 13.3 (SE = 0.81); *Medium:* 14.4 (SE = 0.52); High: 16.9 (SE = 0.51).
Edholm et al., 2019	Kistler 9281 Force Platform	Concentric phase of jump on to force platform, 3 attempts, max used	LB MS	Squat jump test	N/kg	8.4 (1.8)
Foong et al., 2016	100 kg Pocket Balance Dynamometer	MVC isometric KES, dominant leg	LB MS	KES	Kg	*M:* 39.3 (8.1); *F:* 28.2 (9.1)
		MVC leg strength lifting a bar, both legs (simultaneously)	LB MS	Leg strength	Kg	*M:* 129.0 (39.5); *F:* 56.4 (27.1)
Gennuso et al., 2016	Dynamometer N/R	N/R	UB MS	HGS	N/R	N/R
	N/A	Time to complete 5 chair stands	LB MP	5x CST (0-4)	Points	*M:* 2.5 [1.0-3.5]; *F:* 2.5 [1.5-3.0]
Gerdhem et al., 2007	Bidoex Computerized Dynamometer 4.5.0.	Isometric KES, three attempts, max used	LB MS	KES	NmS	246 (71)
		Isometric knee flexion strength, three attempts, max used	LB MS	Knee flexion strength	NmS	117 (37)
Hall et al., 2016	N/A	# chair stands completed in 30 s	LB MP	30 s CST	#/30 s	*60-69:*15.8 (4.5); *70-79:* 14.1 (4.9); *80-90+:* 10.9 (4.8)
Harada et al., 2016	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	7.7 (2.2)
Hartley et al., 2018	Jamar Dynamometer	HGS, 3 attempts with each hand, max used	UB MS	HGS	Kg	21.8 (4.9)
	Mechanography Ground	One legged jump strength, 3 attempts, max used	LB MS	Jump strength	KiloN	1.3 (0.2)
	Reaction Force Platform	Two legged jump power, three 3, maxed used	LB MP	Jump power	KiloW	1.4 (0.3)
	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	12.9 (4.2)
Hasegawa et al., 2018	N/A	# chair stands completed in 30 s	LB MP	30 s CST	#/30 s	15.4 (4.3)
Hernandes et al., 2013	Takei Dynamometer	HGS, 2 attempts with each hand, max used	UB MS	HGS	KgF	*Exercise:* 27 [23-33]; *Non-exercise:* 25 [22-34]
	N/A	# chair stands completed in 30 s	LB MP	30 s CST	#/30 s	*Exercise:* 13 [12-15]; *Non-exercise:* 12 [10-13]
Hernández et al., 2017	Bilateral Leg Press Technogym	1RM leg press KES, 4-5 attempts, max used	LB MS	KES	Kg	195.8 (76.8)
		Quadriceps power at 50% and 70% of individual's	LB MP	Quad power 50%	W	576.4 (250.4)
		1RM, 2 attempts, max used	LB MP	Quad power 70%	W	571.3 (245.9)
Hopkins 2019	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	N/R
Iijima et al., 2017	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	*Basal activity:* 10.5 (3.42); *Limited activity:* 9.06 (2.33); *Low active:* 8.55 (2.86); *Physically active:* 7.90 (1.74)
Ikenaga et al., 2014	Smedley Dynamometer TKK5401 GRIP-D	HGS, 2 attempts with both hands, max used	UB MS	HGS	Kg	35.4 (5.3)
		HGS, 2 attempts, max used	LB MS	KES		2.35 (0.54)

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Table C4 (*continued*)

Author year	Device/equipment	Definition and protocol	Measure type	Reported measure (s)	Units	Mean (SD)[a]
	Dynamometer TKK5717 & TKK5710e				Nm/kg	
Iwakura et al., 2016	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	11.05 (3.19)
	N/A	# of full flexion and extension of the elbow (arm curls) with dumbbells *F:* 5 pounds and *M:* 8 pounds completed in 30 s	UB MP	Arm Curl	#/30 s	16.0 (3.5)
Jantunen et al., 2017	N/A	# chair stands completed in 30 s	LB MP	30 s CST	#/30 s	11.5 (2.3)
Jeong et al., 2019	Lafayette Instrument Handheld Dynamometer	Isometric KES, 2 attempts with most OA symptomatic knee, 2 attempts, mean used divided by weight	LB MS	KES	N/kg	2.8 (0.8)
		Isometric hip abductor strength, 2 attempts on side of most OA symptomatic knee, mean used divided by weight	LB MS	Hip strength	N/kg	0.7 (0.3)
Johnson et al., 2016	TTM Muscular Meter Dynamometer	Isometric hip extensor and quadricep strength, 2 attempts in both legs (simultaneously), max used	LB MS	Leg strength	Kg	97.58 (51.13)
Kawagoshi et al., 2013	Hydromusculator GT-160	Isometric extension and contraction of quadriceps femoris	LB MS	KES	N/R	N/R
Keevil et al., 2016	Smedley Dynamometer	HGS, 2 attempts with each hand, max used	UB MS	HGS	Kg	N/R
	N/A	Time to complete 5 chair stands	UB MS	5x CST`	#/min	N/R
Kim, 2015	Smedley Dynamometer	HGS, 2 attempts with each hand, max used	UB MS	HGS	Kg	23.4 (7.5)
	µTas Dynamometer F-1 ANIMA	Isometric KES, 2 attempts with dominant leg, max/weight used	LB MS	KES	N/kg	1.15 (0.33)
Kim et al., 2015	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	8.9 (2.1)
Lai et al., 2020	N/A	Time to complete 5 chair stands, *M:* > or < 6.95 s, *F:* > or <6.88s	LB MP	5x CST (high vs. low)	S	N/R
Lee et al., 2015	N/A	Time to complete 5 chair stands	LB MP	5x CST	#/min	N/R
Lerma et al., 2018	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	15.2 (4.8)
Liao et al., 2018	Jamar Dynamometer	HGS, 2 attempts with one hand, max used	UB MS	HGS	Kg	27.4 (8.4)
Lohne-Seiler et al., 2016	Hydraulic Dynamometer	HGS, 3 attempts with dominant hand, max used	UB MS	HGS (adjusted for age, sex, test center)	Kg	33.5 (95% CI: 32.3, 34.8)
Mador et al., 2011	HF Star	Quadriceps strength dynamic contractions against hydraulic resistance, 2 sets of 3 contractions at highest resistance, max used	LB MS	KES	Kg	48.03 (12.29)
Matkovic et al., 2020	KERN MAP 80K1 Handheld Dynamomete	HGS, 3 attempts with each hand, max used	UB MS	HGS	Kg	Right hand: 30.7 (10.1); Left hand: 29.1 (9.2)
	N/A	# chair stands completed in 30 s	LB MP	30 s CST	#/30 s	11 (3)
Master et al., 2018	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	10.5 (2.9)
McDermott et al., 2002	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	N/R
McGregor et al., 2018	Hand Dynamometer	HGS, 2 attempts, max used	UB MS	HGS	Kg	N/R
Meier and Lee, 2020	Jamar Plus + Digital Dynamometer	HGS, 3 attempts with each hand, max used	UB MS	HGS	Kg	29.9 (10.3)
	N/R	1RM chest press, progressive reps increasing in weight, max used	UB MS	Chest press strength	Lbs	75.2 (37.2)
	N/R	1RM leg press, progressive reps increasing in weight, max used	LB MS	Leg press strength	Lbs	183.9 (78.0)
Monteiro et al., 2019	N/A	# of full flexion and extension of the elbow (arm curls) with dumbbells *F:* 5 pounds and *M:*8 pounds completed in 30 s	UB MP	Arm curl	#/30 s	*T1:* 25.8 (9.75); *T2:* 30.50 (8.88); *T3:* 32.60 (8.36)
	Bidoex System 2 (custom)	Isokinetic KES, measured at 180°/sec, five attempts, max used	LB MS	KES	Nm	*T1:* 57.65 (15.36); *T2:* 65.10 (15.24); *T3:* 69.93 (17.51)
	Bidoex System 2 (custom)	Isokinetic knee flexion strength, measured at 180°/sec, five attempts, max used	LB MS	Knee flexion strength	Nm	*T1:* 33.39 (11.38) *T2:* 36.54 (12.24); *T3:* 42.02 (9.23)
	N/A	# chair stands completed in 30 s	LB MP	30 s CT	#/30 s	*T1:* 20.55 (5.73); *T2:* 21.75 (7.33); *T3:* 25.10 (5.93)
Morie et al., 2010	Jamar Dynamometer	HGS, 3 attempts with each hand, max used	UB MS	HGS	Kg	N/R
	Keiser A420	Chest and leg press 1RM determined, 2 trials, max used and power at varying % of 1RM for chest press and leg press assessed, max power used for analysis	UB MS	Chest press strength	N	N/R
	Pneumatic Resistance Machine		UB MP	Chest press power	W	N/R
			LB MS	Leg press strength	N	N/R
			LB MP	Leg press power	W	N/R
Nagai et al., 2018	Smedley Dynamometer GRIP-A	N/R, *M:*> or <26 kg and *F:* > or <18 kg	UB MS	HGS (weak vs. not weak)	Kg	26.7 (7.6)
	N/A		UB MP	Arm curl	#/30 s	N/R

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Table C4 (*continued*)

Author year	Device/equipment	Definition and protocol	Measure type	Reported measure (s)	Units	Mean (SD)[a]
Nawrocka et al., 2017	N/A	# of full flexion and extension of the elbow (arm curls) with dumbbells *F:* 5 pounds and *M:*8 pounds completed in 30 s # chair stands completed in 30 s	LB MP	30 s CSTs	#/30 s	N/R
	Jamar Dynamometer	HGS, two attempts, max used	UB MS	HGS	Kg	*Not meeting PA guidelines:* 22.87 (5.05); *Meeting PA guidelines:* 24.99 (5.60)
Nawrocka et al., 2019	N/A	# of full flexion and extension of the elbow (arm curls) with dumbbells *F:* 5 pounds and *M:*8 pounds completed in 30 s	UB MP	Arm curl	#/30 s	*Not meeting PA guidelines:* 16.04 (4.03); *Meeting PA guidelines:* 17.87 (3.76)
	N/A	# chair stands completed in 30 s	LB MP	30 s CST	#/30 s	*Not meeting PA guidelines:* 14.36 (3.27); *Meeting PA guidelines:* 14.92 (3.59)
Nicolai et al., 2010	N/A	Time to complete 5 chair stands	LB MP	5x CST	S S	Unadjusted Unadjusted
Ofei-Doodoo et al., 2018	N/A	# of full flexion and extension of the elbow (arm curls) with dumbbells *F:* 5 pounds and *M:*8 pounds completed in 30 s # chair stands completed in 30 s	UB MP	Arm curl	#/30 s	N/R
	N/A		LB MP	30 s CST	#/30 s	N/R
Orwoll et al., 2019	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	*No falls:* 11.2 (3.2); *One falls:* 11.6 (3.3); *≥Two falls:* 12.3 (4.4)
Osuka et al., 2015	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	N/R
Park et al., 2018	Dynamometer N/R	HGS, two attempts with each hand, max/weight x 100 used	UB MS	HGS	%	52.0 (7.8)
	N/A	# chair stands completed in 30 s, 2 attempts, max used	LB MS	30 s CST	#/30 s	20.7 (4.2)
Perkin et al., 2018	Keijzer A420	Leg press 1RM, force-velocity evaluation to determine max force (strength) and max power	LB MS	Leg press strength	N	N/R
			LB MP	Leg press power	W	N/R
Pitta et al., 2005	Jamar Dynamometer	Isometric HGS, 3 attempts with each hand, sum of max on each hand used, % predictive	UB MS	HGS	% pred	92 (24)
	Cybex Norm Jamar Dynamometers	Isometric knee extension torque, % predictive (pred)	LB MS	Knee extension torque	% pred	56 (10)
Puthoff et al., 2008	Keiser 420 Leg Press	Leg press 1RM, peak power, power at 40% of 1RM, and power at 90% of 1RM assessed, 3 attempts, max result for each used	LB MS	Leg press strength	N/kg	15.5 (4.0)
			LB MP	Leg press power peak	W/kg	7.6 (2.7)
			LB MP	Leg press power 40%	W/kg	7.1 (2.7)
			LB MP	Leg press power 90%	W/kg	5.7 (2.4)
Rapp et al., 2012	Jamar Dynamometer	HGS, two attempts in each hand, mean of each hand calculated and max used	UB MS	HGS	Kg	*M:* 38.8 (9.40); *F:* 23.7 (6.56)
	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	*M:* 11.1 (3.42); *F:* 11.6 (3.73)
Rausch-Osthoff et al., 2014	Strain Gauge connected to Interface Series SM S-Type Load Cell and Nexus-10 device	MVC isometric KES, left leg, 3 attempts mean used	LB MS	KES	Nm	14.5 (5.2)
Rava et al., 2018	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	9.6 (2.0)
Reid et al., 2018	Lord's Strap Assembly	1RM KES, 2 attempts with each leg, max used	LB MS	KES	Kg	25.2 (11.2)
	1RM Bilateral Leg Press	N/R	LB MS	Leg press strength	Kg	128/7 (51.2)
	N/A	# chair stands completed in 30 s,	LB MP	30 s CT	#/30 s	12.3 (2.4)
Rojer et al., 2018	Jamar Dynamometer	HGS, 3 attempts with each hand, max used	UB MS	HGS	Kg	31.5 (9.5)
Rosenberg et al., 2015	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	13.0 (3.4)
Rowlands et al., 2018	N/R	HGS, 3 attempts with each hand, max used	UB MS	HGS		28.5 (10.1)
	N/A	# chair stands completed in 30 s, 2 attempts, max used	LB MP	60 s CST		22.1 (7.8)
Safeek et al., 2018	Jamar Dynamometer	HGS, 2 attempts with dominant hand, max used	UB MS	HGS	Kg	*M:* 38.00 [9.75]; *F:* 25.00 [2.50]
	N/A	# chair stands completed in 30 s, 2 attempts, max used	LB MP	30 s CST	#/30 s	14.00 [6.00]
Sánchez-Sánchez et al., 2019	Jamar Dynamometer	HGS, 3 attempts with each hand, max used	UB MS	HGS	Kg	22.26 (8.21)
Santos et al., 2012	N/A	# of full flexion and extension of the elbow (arm curls) with dumbbells *F:* 5 pounds and *M:* 8 pounds completed in 30 s # chair stands completed in 30 s	UB MP	Arm Curl	#/30 s	16.3 (5.3)
	N/A		LB MP	30 s CST	#/30 s	13.7 (4.7)
Sardinha et al., 2015	N/A N/A	# of full flexion and extension of the elbow (arm curls) with dumbbells F: 5	UB MP LB MP	Arm Curl 30 s CST	#/30 s #/30 s	16.9 (5.2) 14.4 (4.5)

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Table C4 (*continued*)

Author year	Device/equipment	Definition and protocol	Measure type	Reported measure (s)	Units	Mean (SD)[a]
		pounds and M:8 pounds completed in 30 s # chair stands completed in 30 s				
Scott et al., 2020	Patterson Medical Jamar Dynamometer	HGS, 2 attempts, max used	UB MS	HGS	Kg	*Non-sarcopenic:* 34.7 (10.6); *Sarcopenic:* 16.5 (5.8)
Scott et al., 2011	TTM Muscular Meter Dynamometer	Isometric hip extensor and quadricep strength, 2 attempts in both legs (simultaneously), max used	LB MS	Leg strength	Kg	96.2 (49.4)
Scott et al., 2009	TTM Muscular Meter Dynamometer	Isometric hip extensor and quadricep strength, 2 attempts in both legs (simultaneously), max used	LB MS	Leg strength	Kg	*Sedentary:* 84.3 (47.5); *Low active:* 4.4 (47.3); *Somewhat active:* 88.3 (48.8); *Active:* 99.4 (48.5); *Highly active:* 102.7 (51.1)
Semanik et al., 2015	N/A	Time to complete 5 chair stands	LB MP	5x CST	#/min	30.6 (11.2)
Silva et al., 2019	N/A	# of full flexion and extension of the elbow (arm curls) with dumbbells *F:* 5 pounds and *M:* 8 pounds completed in 30 s	UB MP	Arm Curl	#/30 s	20.07 (6.69)
	N/A	# chair stands completed in 30 s	LB MP	30 s CST	#/30 s	15.04 (5.06)
Spartano et al., 2019	Jamar Dynamometer	HGS, 3 attempts with each hand, max used	UB MS	HGS	Kg	*M:* 39.1 (8.7)*; F:* 23.3 (5.7)
	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	9.9 (2.6)
Tang et al., 2015	Jamar Dynamometer	Isometric HGS, 3 attempts with each hand, mean used	UB MS	HGS	Kg	16.3 [11.3-20.2]
Trayers et al., 2014	N/A	Time to complete 5 chair stands	LB MP	5x CST (0-4)	Points	N/R
Sullivan and Feinn, 2012	Bremshey Hand Dynamometer	Dominant hand	UB MS	HGS	Kg	37.3 (10.2)
	N/A	# chair stands completed in 60 s	LB MP	60 s CST	#/60 s	20 (6)
Van Lummel et al., 2016	N/A	Time to complete 4.5 chair stands (ending seated)	LB MP	5x CST	S	14.9 (6.6)
van Oeijen et al., 2020	MicroFET Hand-held Dynamometer	"Make" test of the hip flexors, hip abductors, knee extensors and ankle dorsal flexors, N/R	LB MS	Lower extremity strength	Z-scores	Baseline: -1.00 (1.15); FU: 1.36 (1.06)
Van Sloten et al., 2011	Jamar Dynamometer	HGS, 3 attempts with each hand, max used, sex specific 20[th] percentiles used as cut off points for presence of low HGS	LB MS	HGS	Kg	*M:* 43.4 (9.87); *F:* 26.1 (4.9)
Walker et al., 2008	Strain Gauge Transducer and MacLab Bridge Amplifier	MVC isometric quadriceps strength. 3 attempts, max used	LB MS	KES	N	315 (106)
Ward et al., 2014	N/A	# chair stands completed in 30 s	LB MP	30 s CST	#/30 s	*F:* 15.72 (4.13); *M:* 17.51 (5.89)
Waschki et al., 2012	Strain Gauge Dynamometer	MVC isometric quadriceps strength, mean used	LB MS	KES	Kg	32.0 (13.2)
Watz et al., 2008	Handgrip dynamometer (N/R)	N/R	LB MS	HGS	Kg	35.3 (9.6)
Westbury et al., 2018	Jamar hydraulic Dynamometer	HGS, 3 attempts with each hand, max used	UB MS	HGS	Kg	*M:* 34.8 (6.5); *F:* 20.7 (5.6)
Wickerson et al., 2013	Isokinetic Dynamometer	Isometric quadriceps torque	LB MS	Knee extension torque	Nm	120 (36)
Winberg et al., 2015	Biodex Multi- Joint System 3 PRO Dynamometer	MVC knee extension and knee flexion strength, both legs (less affected leg and more affected leg by polio), peak torques used	LB MS	KES	Nm	Less affected leg: 104 (43); More affected leg: 69 (43)
			LB MS	Knee flexion strength	Nm	Less affected leg: 59 (25); More affected leg: 36 (24)
Yamada et al., 2011	N/A	Time to complete 5 chair stands	LB MP	5x CST	S	*Non-frail:* 8.9 (3.6); *Frail:* 17.6 (8.5)
Yasunaga et al., 2017	Smedley Dynamometer TKK5041	HGS, 1 attempt with dominant hand	UB MS	HGS	Kg	27.4 (8.3)
Yoshida et al., 2010	Smedley Dynamometer	HGS, 2 attempts with each hand, mean calculated and max used	UB MS	HGS	Kg	*HFG:* 17.9 (4.0); *LFG:* 15.1 (4.0)
		Isometric KES, two attempts with each leg, max of each leg added and multiplied by leg length converted into torque and divided by weight	LB MS	KES	Nm/kg	*HFG:* 2.10 (0.69); *LFG:* 2.61 (0.87)
Yuki et al., 2019	N/R	HGS, *M:* > or < 26 kg *F:* > or < 18 kg	UB MS	HGS (+/-weakness)	Kg	N/R

UB = upper body, LB = lower body, MS = muscle power, MP = muscle strength, HGS = hand grip strength, KES = knee extension strength, KET = knee extension torque, CST = chair stand test, s = seconds, x = times (repetitions), #=number, quad = quadriceps, kg = kilogram, N = newton, Nm = newton-meter, W = watt, KgF = kilogram-force, KiloW = kilowatt, KiloN = kilonewton, MVC = maximum voluntary contraction, 1RM = one repetition maximum, max = maximum, / =divided by or per, Δ=change, %pred=% predictive, +/- =with or without, N/A = not applicable, N/R = not reported, M = male, F = female, HFG = high functioning group, LFG = low functioning group, OA = osteoarthritis. Underlined articles have a longitudinal design.

[a] Mean (standard deviation (SD)) of muscle strength and muscle power are presented unless reported as median [interquartile range], or mean {range}. *Subgroups* for stratified results are presented in italics.

Table C5
Associations between physical activity and sedentary behavior with muscle strength and muscle power in older adults.

Author year	Physical activity and sedentary behavior: Reported measure (s)	Physical activity and sedentary behavior: Units	Muscle strength and muscle power: Reported measure(s)	Muscle strength and muscle power: Units	Adjustment	Effect size (95% CI)[a]	p-value used for analyses[b]
Abe et al., 2015	Steps	#/day	KES/weight	Kg/Nm	Age	Partial R = 0.242 (p > 0.05)	"Abe 2012"
	MVPA	Min/day	KES/weight	Kg/Nm	Age	Partial R = 0.233 (p > 0.05)	"Abe 2012"
	LPA (*LPA-MPA*)	Min/day	KES/weight	Kg/Nm	Age	Partial R = 0.217 (p > 0.05)	"Abe 2012"
	Steps	#/day	Toe grasping/ weight	Kg/kg	Age	Partial R = 0.283 (0.01 > p < 0.05)	0.01 > p < 0.05
	MVPA	Min/day	Toe grasping/ weight	Kg/kg	Age	Partial R = 0.228 (p > 0.05)	p(calc) = 0.881
	LPA (*LPA-MPA*)	Min/day	Toe grasping/ weight	Kg/kg	Age	Partial R = 0.290 (0.01 > p < 0.05)	0.01 > p < 0.05
Abe et al., 2012	Steps	#/day	KES	Nm	Unadjusted	R = 0.351 (p = 0.015)	p = 0.015
	VPA	Min/day	KES	Nm	Age, sex, height, weight	Partial R = 0.184 (p > 0.05)	
	MVPA (*MPA)*	Min/day	KES	Nm	Age, sex, height, weight	Partial R = 0.197 (p > 0.05)	p(calc) = 0.180
	LPA	Min/day	KES	Nm	Age, sex, height, weight	Partial R = 0.155 (p > 0.05)	p(calc) = 0.293
	EE	Kcal/day	KES	Nm	Unadjusted	R = 0.421(p = 0.004)	p = 0.004
	Steps	#/day	Knee flexion strength	Nm	Age, sex, height, weight	Partial R = 0.369 (p = 0.014)	p = 0.014
	VPA	Min/day	Knee flexion strength	Nm	Age, sex, height, weight	Partial R = 0.236 (p > 0.05)	
	MPA	Min/day	Knee flexion strength	Nm	Age, sex, height, weight	Partial R = 0.438 (p = 0.003)	p = 0.003
	LPA	Min/day	Knee flexion strength	Nm	Age, sex, height, weight	Partial R = 0.089 (p > 0.05)	p(calc) = 0.547
	EE	Kcal/day	Knee flexion strength	Nm	Age, sex, height, weight	Partial R = 0.409 (p = 0.006)	p = 0.006
Aggio et al., 2016	MVPA	Sqrt(min/ day)	HGS	Kg	Age, waist circumference	B = 0.58 (0.34, 0.82)	p < 0.001
	LPA	Min/day	HGS	Kg	Age, waist circumference	B = 0.21 (-0.06, 0.48)	p = 0.125
	SB	30 min/day	HGS	Kg	Age, waist circumference	B=-0.20 (-0.41, 0.01)	p = 0.062
	BST	#/h	HGS	Kg	Age, waist circumference	B = 0.14 (-0.14, 0.42)	p = 0.329
Alcazar et al., 2018	MVPA	% wear time	Leg press strength	N	Unadjusted	R = 0.41 (p < 0.05)	p(calc) = 0.021
	SB	% wear time	Leg press strength	N	Unadjusted	R = N/R (p > 0.05)	p(N/R)>0.25
	MVPA	% wear time	Leg press power	W/kg	Unadjusted	R = 0.59 (p < 0.01)	p(calc)<0.001
	SB	% wear time	Leg press power	W/kg	Unadjusted	R = N/R (p > 0.05)	p > 0.25
Alzahrani et al., 2012	Activity counts	#/day	KES	N	Unadjusted	R = 0.03 (p = 0.85)	p = 0.85
	TPA	Min/day	KES	N	Unadjusted	R = 0.18 (p = 0.25)	p = 0.25
Andersson et al., 2013	EE *(PAL)*	None	KES	Kg	Age, sex, gait speed + others	B = 0.004 (0.000, 0.008)	p = 0.242
André et al., 2018	MVPA	Min/day	Calf raise (high vs. low)	#/30 s	Unadjusted	*Cohen's d = 0.97 (p = 0.04)	p = 0.04
André et al., 2016	MVPA (high vs. low)	Min/day	Calf raise	#/30 s	Unadjusted	R = 0.639 (p = 0.001)	p = 0.001
Aoyagi et al., 2009	Steps	#/day	HGS	N	Age, sex	Partial R = 0.12 (p > 0.05)	p(calc) = 0.119
	TPA	Min/day	HGS	N	Age, sex	Partial R = 0.12 (p > 0.05)	p(calc) = 0.119
	Steps	#/day	Knee extension torque	Nm/kg	Age, sex	Partial R = 0.20 (p < 0.05)	p(calc) = 0.009
	TPA	Min/day	Knee extension torque	Nm/kg	Age, sex	Partial R = 0.21 (p < 0.05)	p(calc) = 0.005
Ashe et al., 2008	Activity counts	#/day	Leg press strength	Kg	Unadjusted	R = 0.284 (p = 0.025)	p = 0.025
	MVPA	Min/day	Leg press strength	Kg	Unadjusted	R = 0.174 (p = 0.175)	p = 0.175
	Activity counts	#/day	Leg press power	W	Unadjusted	R = 0.373 (p = 0.003)	p = 0.003
	MVPA	Min/day	Leg press power	W	Unadjusted	R = 0.260 (p = 0.041)	p = 0.041
Ashe et al., 2007	Steps	#/day	HGS	Kg	Unadjusted	R = 0.22 (p < 0.01)	p(calc) = 0.002
	Steps (high vs. low)	#/day	HGS	Kg	Unadjusted	*OR = 2.04 (0.86, 4.79)	
	Steps	#/day	KES	Kg	Unadjusted	R = 0.31 (p < 0.001)	p < 0.001
Aubertin-Leheudre et al., 2017	Steps	#/day	HGS (dynapenic vs. non-dynapenic)	Kg	Unadjusted	*Non-obese*: T = N/R (+) (p = 0.07)	p = 0.07
						Obese: T = N/R (+) (p = 0.056)	p = 0.056
	Activity counts	#/day	HGS (dynapenic vs. non-dynapenic)	Kg	Unadjusted	*Non-obese*: T = N/R (+) p = 0.0008)	p = 0.0008
						Obese: T = N/R (+) (p = 0.021)	p = 0.021
	TPA	Min/day	HGS (dynapenic vs. non-dynapenic)	Kg	Unadjusted	*Non-obese:* T = N/R (+) (p = 0.005)	p = 0.005
						Obese: T = N/R (+) (p = 0.029)	p = 0.029

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Table C5 (*continued*)

Author year	Physical activity and sedentary behavior		Muscle strength and muscle power		Adjustment	Effect size (95% CI)[a]	p-value used for analyses[b]
	Reported measure (s)	Units	Reported measure(s)	Units			
Balducci et al., 2017	MVPA	Min/day	Shoulder press strength	Nm	Unadjusted	Rho = 0.397 (p < 0.001)	p < 0.001
	LPA	H/day	Shoulder press strength	Nm	Unadjusted	Rho = 0.281 (p < 0.001)	p < 0.001
	SB	H/day	Shoulder press strength	Nm	Unadjusted	Rho=-0.235(p < 0.001)	p < 0.001
	MVPA	Min/day	Leg press strength	Nm	Unadjusted	Rho = 0.412 (p < 0.001)	p < 0.001
	LPA	H/day	Leg press strength	Nm	Unadjusted	Rho = 0.341 (p < 0.05)	p < 0.001
	SB	H/day	Leg press strength	Nm	Unadjusted	Rho=-0.299 (p < 0.001)	p < 0.001
Bann et al., 2015	TPA	H/day	HGS	Kg	Age, sex, wear time	B = 0.06 (-0.03, 0.16)	p = 0.191
	Higher LPA	H/day	HGS	Kg	Age, sex, wear time	B = 2.41 (0.16, 4.66)	
	LPA (*Lower LPA*)	H/day	HGS	Kg	Age, sex, wear time	B = 0.06 (-0.42, 0.54)	p = 0.809
	SB	H/day	HGS	Kg	Age, sex, wear time	B=-0.13 (-0.55, 0.28)	p = 0.527
Barbat-Artigas et al., 2012	Steps	#/day	HGS	Kg	Unadjusted	R = N/R (p > 0.05)	p(N/R)>0.25
	TPA	Min/day	HGS	Kg	Unadjusted	R = N/R (p > 0.05)	p(N/R)>0.25
	Steps	#/day	KES	N	Unadjusted	R = N/R (p > 0.05)	p(N/R)>0.25
	TPA	Min/day	KES	N	Unadjusted	R = N/R (p > 0.05)	p(N/R)>0.25
	Steps	#/day	20 s CST	#/20 s	Unadjusted	R = N/R (p > 0.05)	p(N/R)>0.25
	TPA	Min/day	20 s CST	#/20 s	Unadjusted	R = N/R (p > 0.05)	p(N/R)>0.25
Bartlett and Duggal, 2020	Steps (active vs. sedentary)	#/day	HGS	Kg	Unadjusted	T = N/R (+) (p = 0.69)	p = 0.69
Bassey et al., 1988	Steps (*step score*)	#/day x 10^3	Calf strength	N	Unadjusted	*F:* Pearson's R = N/R (p > 0.05)	p(N/R)>0.25
						M: Pearson's R = 0.30 (p < 0.05)	p(calc) = 0.025
Bogucka et al., 2018	Steps	#/day	HGS	Kg	Unadjusted	*Dynapenic:* R=-0.12 (p = 0.74)	p = 0.74
						Non-dynapenic: R = 0.16 (p = 0.34)	p = 0.34
Bollaert and Motl, 2019	MVPA	% wear time	5x CST (0-4)	Points	MS, SB, long SB bouts	B = 9.07 (SE = 5.14) β = 0.18	p(calc) = 0.077
	LPA	% wear time	5x CST (0-4)	Points	Unadjusted	R = 0.40 (p < 0.01)	p(calc)<0.001
	SB	% wear time	5x CST (0-4)	Points	MS, MVPA, long SB bouts	B=-2.98 (SE = 1.46) β=-0.20 s	p(calc) = 0.041
	PA bouts	#/day	5x CST (0-4)	Points	Unadjusted	R = 0.34 (p < 0.01)	p(calc) = 0.002
	PA bouts	Min/bout/ day	5x CST (0-4)	Points	Unadjusted	R = 0.15 (p > 0.01)	p(calc) = 0.184
	SB bouts	#day	5x CST (0-4)	Points	Unadjusted	R=-0.01 (p > 0.01)	p(calc) = 0.930
	SB bouts	Min/bout/ day	5x CST (0-4)	Points	Unadjusted	R=-0.33 (p < 0.01)	p(calc) = 0.003
	Long SB bouts	#/day	5x CST (0-4)	Points	Unadjusted	R=-0.32 (p < 0.01)	p(calc) = 0.004
	Long SB bouts	Min/bout/ day	5x CST (0-4)	Points	MS, MVPA, SB	B=-0.04 (SE = 0.02) β=-0.25	p(calc) = 0.045
Boutou et al., 2019	*Actigraph measures:*						
	ΔSteps	#/day	KES	Kg	Age, 6MWD, climate + others	*B=-1.00E-4 (-0.004,0.005)	
	ΔMVPA	Ratio	KES	Kg	Age, 6MWD, climate + others	*B=-0.004 (-0.016, 0.009)	p = 0.535
	ΔVMU	#/day	KES	Kg	Age, 6MWD, climate + others	*B=-0.003 (-0.007, 0.001)	
	Dynaport measures:						
	ΔSteps	#/day	KES	Kg	Age, 6MWD, climate + others	*B=-2.10E-4 (-0.005, 0.005)	p = 0.932
	ΔSteps (*Walking*)	Min/day	KES	Kg	Age, 6MWD, climate + others	*B = 0.002 (-0.003, 0.067)	
	ΔMET	G	KES	Kg	Age, 6MWD, climate + others	*B=-0.001 (SE = 6.00E-4)	p = 0.036
	ΔVMU	#/day	KES	Kg	Age, 6MWD, climate + others	*B=-0.005 (SE = 0.002)	p = 0.03
Carrasco Poyatos et al., 2016	MVPA	CPM	HGS	Kg	Unadjusted	R = 0.42 (p = 0.01)	p = 0.01
Chastin et al., 2012	SB	H/day	Leg extension power	N/R	Unadjusted	*M:* R = 0.739 (p = 0.003)	p = 0.003
						F: R = 0.151 (p = 0.678)	p = 0.678
	SB break rate	#/sedentary h	Leg extension power	N/R	Unadjusted	*M:* R=-0.683 (p = 0.07)	p = 0.07
						F: R=-0.158 (p = 0.663)	p = 0.663
Chmelo et al., 2013	Steps	#/day	KES	N	Unadjusted	R = 0.13 (p = 0.15)	p = 0.15
	MVPA	Min/day	KES	N	Unadjusted	R = 0.09 (p = 0.33)	p = 0.33
	LPA	Min/day	KES	N	Unadjusted	R=-0.04 (p = 0.66)	p = 0.66
	EE	Kcal/day	KES	N	Unadjusted	R = 0.23 (p = 0.01)	p = 0.01
Cooper et al., 2015	MVPA	SDs	HGS	Kg	Sex	β = 0.638 (0.166, 1.110)	p(calc) = 0.008
	SB	SDs	HGS	Kg	Sex	β=-0.588 (-1.062, -0.115)	p(calc) = 0.015

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Table C5 (*continued*)

Author year	Physical activity and sedentary behavior		Muscle strength and muscle power		Adjustment	Effect size (95% CI)[a]	p-value used for analyses[b]
	Reported measure (s)	Units	Reported measure(s)	Units			
	EE	SDs	HGS	Kg	Sex	β = 0.632 (0.158, 1.105)	p(calc) = 0.009
	MVPA	SDs	10x CST	#/min	Sex	β = 0.670 (0.321, 1.018)	p(calc)<0.001
	SB	SDs	10x CST	#/min	Sex	β=-0.550 (-0.898, -0.201)	p(calc) = 0.002
	EE	SDs	10x CST	#/min	Sex	β = 0.943 (0.594, 1.292)	p(calc)<0.001
Davis et al., 2014	MVPA	Log(min/h)	5x CST (0-4)	Points	Age, sex, BMI, edu	B = 0.851 (0.429, 1.272)	p < 0.001
	SB	Min/h	5x CST (0-4)	Points	Age, sex, BMI, edu, MVPA	B=-0.042 (-0.073, -0.011)	p = 0.009
	BST	#/h	5x CST (0-4)	Points	Age, sex, BMI, edu, MVPA, SB	B = 0.334 (0.178, 0.490)	p < 0.001
de Melo et al., 2010	Steps	#/day	30 s CST	#/30 s	Age, self-rate health, income	*RR = 1.04 (1.00, 1.07)	"De Melo 2014"
de Melo et al., 2014	Steps (medium vs. low)	#/day	Arm Curl	#/30 s	Age, sex, morbidities	*OR= 1.01 (0.77-1.32)	
	Steps (high vs. low)	#/day	Arm Curl	#/30 s	Age, sex, morbidities	*OR= 1.35 (1.00-1.82)	p = 0.04
	Steps (medium vs. low)	#/day	30 s CST	#/30 s	Age, sex, morbidities	*OR = 1.00 (0.82-1.18)	p = 0.004
	Steps (high vs. low)	#/day	30 s CST	#/30 s	Age, sex, morbidities	*OR = 1.61 (1.17-2.21)	
Demeyer et al., 2019	ΔSteps (persistently active vs. decline)	#/day	ΔHGS	N	Baseline HGS	EMM(N/R) (p-trend = 0.48)	
	ΔSteps (persistently active vs. inactive)	#/day	ΔHGS	N	Baseline HGS	EMM(N/R) (p-trend = 0.39)	
	Steps (active, somewhat active, inactive, very inactive)	#/day	ΔHGS	N	Baseline HGS	EMM(N/R) (p-trend = 0.84)	p = 0.84
	MVPA (quartiles)	Min/day	ΔHGS	N	Baseline HGS	EMM (N/R) (p-trend = 0.32)	p = 0.32
	SB (quartiles)	Min/day	ΔHGS	N	Baseline HGS	EMM (N/R) (p-trend = 0.24)	p = 0.24
Distefano et al., 2018	Steps	#/day	KES	Kg/kg	Age, sex	Partial R = 0.294 (p = 0.154)	p = 0.154
	Steps	#/day	5x CST	S	Age, sex	Partial R=-0.301 (p = 0.153)	p = 0.153
Dogra et al., 2017	BST	#/day	HGS	Kg	Age, sex, BMI, edu, + others		p = 0.09
	Long SB bouts	% time/day	HGS	Kg	Age, sex, BMI, edu, + others		p = 0.13
Dohrn et al., 2020	SB	Min/day	5x CST (able vs. non-able)	None	Age, sex, BMI, edu, + others	OR = 39.5 (p < 0.05)	0.01 < p < 0.05
	SB break rate	#/sedentary H	5x CST (able vs. non-able)	None	Age, sex, BMI, edu, + others	OR = 0.9 (p > 0.05)	p(N/R)>0.25
	SB bouts	Min/all SB bouts	5x CST (able vs. non-able)	None	Age, sex, BMI, edu, + others	OR = 4.8 (p < 0.05)	0.01 < p < 0.05
	Long SB bouts	Min	5x CST (able vs. non-able)	None	Age, sex, BMI, edu, + others	OR = 11.8 (p > 0.05)	p(N/R)>0.25
Dos Santos et al., 2019	MVPA (sufficient vs. insufficient)	Min/day	HGS (high vs. low)	Kg	Unadjusted	OR = 3.03 (1.38, 6.63)	p = 0.004
Duncan et al., 2016	Steps (high, medium, low)	#/day	Arm curl	#/30 s	Age	Partial η^2 = 0.168 (p = 0.001)	p = 0.001
	Steps (high, medium, low)	#/day	30 s CST	#/30 s	Age	Partial η^2 = 0.095 (p = 0.001)	p = 0.001
Edholm et al., 2019	Activity counts	#/min/day	Squat jump test	N/kg	Fat mass, self-reported past PA	ANOVA (+) (p < 0.001)	p < 0.001
	MVPA	Min/day	Squat jump test	N/kg	Fat mass, self-reported past PA	ANOVA (+) (p = 0.081)	p = 0.081
Foong et al., 2016	Activity counts	#/10000	KES	Kg	Age residuals, sex	β = 0.17 (0.12, 0.22)	p < 0.001
	VPA	10 min/day	KES	Kg	Age residuals, sex	β = 2.7 (1.0, 4.5)	
	MVPA (*MPA*)	10 min/day	KES	Kg	Age residuals, sex	β = 0.6 (0.3, 0.8)	p < 0.001 p = 0.019
	LPA	10 min/day	KES	Kg	Age residuals, sex	β = 0.1 (0.02, 0.20)	p = 0.415
	SB	10 min/day	KES	Kg	Age residuals, sex	β=-0.03 (-0.1, 0.04)	p < 0.001
	Activity counts	#/10000	Leg strength	Kg	Age residuals, sex	β = 0.65 (0.46, 0.83)	
	VPA	10 min/day	Leg strength	Kg	Age residuals, sex	β = 7.5 (0.9, 14.1)	p = 0.002
	MVPA (*MPA*)	10 min/day	Leg strength	Kg	Age residuals, sex	β = 1.6 (0.6, 2.7)	p = 0.023
	LPA	10 min/day	Leg strength	Kg	Age residuals, sex	β = 0.4 (0.1, 0.8)	p = 0.438
	SB	10 min/day	Leg strength	Kg	Age residuals, sex	β=-0.1 (-0.4, 0.2)	
Gennuso et al., 2016	SB	H/day	HGS	N/R	Age, sex, wear time, MVPA	β=N/R (p > 0.05)	p(N/R)>0.25
	BST	#/day	HGS	N/R	Age, sex, wear time, MVPA	β=N/R (p > 0.05)	p(N/R)>0.25
	SB break rate	#/sedentary h	HGS	N/R	Age, sex, wear time, MVPA	β=N/R (p > 0.05)	p(N/R)>0.25
	SB bouts	Min/day	HGS	N/R	Age, sex, wear time, MVPA	β=N/R (p > 0.05)	p(N/R)>0.25

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Table C5 (*continued*)

Author year	Physical activity and sedentary behavior		Muscle strength and muscle power		Adjustment	Effect size (95% CI)[a]	p-value used for analyses[b]
	Reported measure (s)	Units	Reported measure(s)	Units			
	Long SB bouts	H/day	HGS	N/R	Age, sex, wear time, MVPA	β=N/R (p > 0.05)	p(N/R)>0.25
	≥40 min SB bouts	H/day	HGS	N/R	Age, sex, wear time, MVPA	β=N/R (p > 0.05)	p(N/R)>0.25
	≥60 min SB bouts	H/day	HGS	N/R	Age, sex, wear time, MVPA	β=N/R (p > 0.05)	p(N/R)>0.25
	SB	H/day	5x CST (0-4)	Points	Age, sex, wear time, MVPA	β=-0.21 (SE = 0.11)	p(calc) = 0.056
	BST	#/day	5x CST (0-4)	Points	Age, wear time, MVPA	*M:* β = 0.06 (SE = 0.02) *F:* β = 0.006 (SE = 0.02)	0.01 < p ≤ 0.05 p(calc) = 0.777
	SB break rate	#/sedentary h	5x CST (0-4)	Points	Age, wear time, MVPA	*M:* β = 0.60 (SE = 0.19) *F:* β = 0.04 (SE = 0.12)	0.001 < p ≤ 0.01 p(calc) = 0.752
	SB bouts	Min/day	5x CST (0-4)	Points	Age, sex, wear time, MVPA	β=-0.10 (SE = 0.03)	0.001 < p < 0.01
	Long SB bouts	H/day	5x CST (0-4)	Points	Age, sex, wear time, MVPA	β=-0.18 (SE = 0.08)	0.001 < p < 0.01
	≥40 min SB bouts	H/day	5x CST (0-4)	Points	Age, sex, wear time, MVPA	β=-0.23 (SE = 0.09)	
	≥60 min SB bouts	H/day	5x CST (0-4)	Points	Age, sex, wear time, MVPA	β=-0.29 (SE = 0.09)	
Gerdhem et al., 2007	Activity counts	#/min/day	KES	NmS	Unadjusted	R = 0.19 (p = 0.209) R = 0.21	p = 0.209
	MVPA	Min/day	KES	NmS	Unadjusted	(p = 0.160) R = 0.09	p = 0.160
	Activity counts	#/min/day	Knee flexion strength	NmS	Unadjusted	(p = 0.564) R = 0.15	p = 0.564
	MVPA	Min/day	Knee flexion strength	NmS	Unadjusted	(p = 0.307)	p = 0.307
Hall et al., 2016	Steps	#/day	30 s CST	#/30 s	Unadjusted	*60-69y:* R = 0.563 (p = 0.000)	p(calc)<0.001
	Steps	#/day	30 s CST	#/30 s	Unadjusted	*70-79y:* R = 0.353 (p = 0.001)	p = 0.001
	Steps	#/day	30 s CST	#/30 s	Unadjusted	*80-90+y:* R = 0.451 (p = 0.021)	p = 0.021
	MVPA	Min/day	30 s CST	#/30 s	Unadjusted	*60-69y:* R = 0.367 (p = 0.000)	p(calc)<0.001
	MVPA	Min/day	30 s CST	#/30 s	Unadjusted	*70-79y:* R = 0.192 (p = 0.030)	p = 0.030
	MVPA	Min/day	30 s CST	#/30 s	Unadjusted	*80-90+y:* R = 0.281 (p = 0.068)	p = 0.068
	SB	% time/day	30 s CST	#/30 s	Unadjusted	*60-69y:* R=-0.359 (p = 0.000)	p(calc) = 0.001
	SB	% time/day	30 s CST	#/30 s	Unadjusted	*70-79y:* R=-0.197 (p = 0.026)	p = 0.026
	SB	% time/day	30 s CST	#/30 s	Unadjusted	*80-90+y:* R=-0.291 (p = 0.059)	p = 0.059
Harada et al., 2016	Steps	#/day	5x CST	S	Unadjusted	R=-0.25 (p < 0.001)	p < 0.001
Hartley et al., 2018	Activity counts (low)	#/impact/day	HGS	Kg	Age	*Low β = 1.09 (0.97, 1.23)	p = 0.14
	Activity counts (med)	#/impact/day	HGS	Kg	Age	*Medium β = 1.15 (0.97, 1.37)	
	Activity counts (high)	#/impact/day	HGS	Kg	Age	*High β = 1.14 (0.95, 1.36)	
	Activity counts (low)	#/impact/day	Jump strength	kN	Age	*Low β = 1.05 (0.90, 1.22)	p = 0.53
	Activity counts (medium)	#/impact/day	Jump strength	kN	Age	*Medium β = 1.18 (0.95, 1.47)	
	Activity counts (high)	#/impact/day	Jump strength	kN	Age	*High β = 1.26 (1.00, 1.57)	
	Activity counts (low)	#/impact/day	Jump power	kW	Age	*Low β = 0.97 (0.83, 1.13)	p = 0.71
	Activity counts (medium)	#/impact/day	Jump power	kW	Age	*Medium β = 1.14 (0.91, 1.42)	
	Activity counts (high)	#/impact/day	Jump power	kW	Age	*High β = 1.08 (0.86, 1.36)	
	Activity counts (low)	#/impact/day	5x CST	S	Age	*Low β = 0.80 (0.70, 0.91)	p(calc)<0.001
	Activity counts (medium)	#/impact/day	5x CST	S	Age	*Medium β = 0.69 (0.57, 0.83)	
	Activity counts (high)	#/impact/day	5x CST	S	Age	*High β = 0.83 (0.68, 1.00)	
Hasegawa et al., 2018	Steps	#/day	30 s CST	#/30 s	Age, sex	*β = 0.20 (p = 0.17)	p = 0.17
Hernandes et al., 2013	Steps	#/day	HGS	KgF	Unadjusted	*Non-exercise:* Rho=-0.10 (p > 0.05) *Exercise:* Rho=-0.11 (p > 0.05)	p(calc) = 0.206 p(calc) = 0.312
	Steps	#/day	30 s CST	#/30 s	Unadjusted	*Non-exercise:* Rho = 0.30 (p < 0.05) *Exercise:* Rho = 0.28 (p < 0.05)	p(calc) = 0.001 p(calc)<0.001
Hernández et al., 2017	TPA	Min/day	KES	Kg	Unadjusted	R = 0.30 (p = 0.07)	p = 0.07
	LPA	Min/day	KES	Kg	Unadjusted	R = 0.27 (p = 0.11)	p = 0.11
	SB	Min/day	KES	Kg	Unadjusted	R=-0.16 (p = 0.35)	p = 0.35
	Steps	#/day	Quad power 50% 1RM	W	Unadjusted	R = 0.30 (p = 0.07)	p = 0.07
	TPA	Min/day	Quad power 50% 1RM	W	BMI	*B = 0.30 (0.19, 0.42) β = 0.76	p < 0.001

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Table C5 (*continued*)

Author year	Physical activity and sedentary behavior		Muscle strength and muscle power		Adjustment	Effect size (95% CI)[a]	p-value used for analyses[b]
	Reported measure (s)	Units	Reported measure(s)	Units			
	MVPA *(MPA)*	Min/day	Quad power 50% 1RM	W	Unadjusted	R = 0.12 (p = 0.48)	p = 0.48
	LPA	Min/day	Quad power 50% 1RM	W	BMI	*B = 0.25 (0.13, 0.36) β = 0.69	p < 0.001
	SB	Min/day	Quad power 50% 1RM	W	Unadjusted	R=-0.13 (p = 0.44)	p = 0.44
	TPA	Min/day	Quad power 70% 1RM	W	Unadjusted	R = 0.37 (p = 0.027)	p = 0.027
	LPA	Min/day	Quad power 70% 1RM	W	BMI	*B = 0.23 (0.10, 0.35) β = 0.62	p = 0.001
	SB	Min/day	Quad power 70% 1RM	W	Unadjusted	R = 0.14 (p = 0.41)	p = 0.41
Hopkins 2019	MVPA (Meeting vs. not meeting guidelines)	Min/day	Δ5x CST	S	Age, sex, race, BMI + others	B=-0.093 (p > 0.05)	p(N/R)>0.25
Iijima et al., 2017	Steps	1000/day	5x CST (quartiles: Q1=worst performance)	S	Age, sex, BMI, OA grade	Ordinal logistic regression OR = 1.22 (1.10, 1.36)	p < 0.001
Ikenaga et al., 2014	Steps	#/day	HGS	Kg	Age, BMI, % body fat	ANCOVA (p-trend = 0.160)	p = 0.160
	MVPA *(MPA)*	Min/day	HGS	Kg	Age, BMI, % body fat	ANCOVA (p-trend = 0.195)	p = 0.195
	LPA	Min/day	HGS	Kg	Age, BMI, % body fat	ANCOVA (p-trend = 0.707)	p = 0.707
	SB	Min/day	HGS	Kg	Age, BMI, % body fat	ANCOVA (p-trend = 0.869)	p = 0.869
	Steps	#/day	KES	Nm/kg	Age, BMI, % body fat	Partial R = 0.167 (p = 0.028)	p = 0.028
	MVPA *(MPA)*	Min/day	KES	Nm/kg	Age, BMI, % body fat	Partial R = 0.208 (p < 0.01)	p(calc) = 0.005
	LPA	Min/day	KES	Nm/kg	Age, BMI, % body fat	Partial R = N/R (p > 0.05)	p(N/R)>0.25
	SB	Min/day	KES	Nm/kg	Age, BMI, % body fat	Partial R=-0.147 (0.053)	p = 0.053
Iwakura et al., 2016	Steps	1000/day	5x CST	S	Unadjusted	R=-0.299 (p > 0.05)	p(calc) = 0.176
	MVPA	Min/day	5x CST	S	Unadjusted	R=-0.384 (p > 0.05)	p(calc) = 0.078
Jantunen et al., 2017	MET	H/day	Arm curl	#/30 s	Age, sex	β = 0.02 (0.02, 0.04)	p = 0.021
	MET	H/day	30 s CST	#/30 s	Age, sex	β = 0.06 (0.05, 0.07)	p < 0.001
Jeong et al., 2019	Steps	#/day	KES	N/kg	Unadjusted	R = 0.09 (p = 0.53)	p = 0.53
	Steps	#/day	Hip strength	N/kg	Adjustment N/R	β = 0.40, R^2 = 0.16 (p < 0.01)	p(calc) = 0.003
Johnson et al., 2016	VPA	Min/day	Leg strength	Kg	Unadjusted	R = 0.184 (p < 0.05)	
	MVPA *(MPA)*	Min/day	Leg strength	Kg	Unadjusted	R = 0.276 (p < 0.01)	p(calc)<0.001
	LPA	Min/day	Leg strength	Kg	Unadjusted	R = 0.120 (p > 0.05)	p(calc) = 0.101
	SB	Min/day	Leg strength	Kg	Unadjusted	R=-0.024 (p > 0.05)	p(calc) = 0.743
Kawagoshi et al., 2013	Steps *(Walking)*	Min/day	KES	N/R	Unadjusted	R = 0.46 (0.01 < p < 0.05)	p(calc) = 0.200
	Standing *(only)*	Min/day	KES	N/R	Unadjusted	R = 0.26 (p > 0.05)	
	MVPA *(Fast walking)*	Min/day	KES	N/R	Unadjusted	R = 0.60 (0.01 < p < 0.05)	p(calc) = 0.001
	LPA *(Slow Walking)*	Min/day	KES	N/R	Unadjusted	R = 0.33 (p > 0.05)	p(calc) = 0.100
	SB *(Sitting)*	Min/day	KES	N/R	Unadjusted	R=-0.24 (p > 0.05)	p(calc) = 0.237
	Lying	Min/day	KES	N/R	Unadjusted	R=-0.17 (p > 0.05)	
Keevil et al., 2016	MVPA (quartiles: Q1=least MVPA)	Min/day	HGS	Kg	Age, wear time	*F:* Q2vs.Q1 B = 1.18 (0.56, 1.79), Q3vs.Q1 B = 0.92 (0.28, 1.55), Q4vs.Q1 B = 2.02 (1.36, 2.68) (p-trend<0.001)	p < 0.001
						M: Q2vs.Q1 B = 0.88 (-0.09, 1.85), Q3vs.Q1 B = 1.83 (0.82, 2.83), Q4vs.Q1 B = 1.26 (0.22, 2.30), (p-trend<0.001)	p < 0.001
	SB (quartiles: Q1=most SB)	H/day	HGS	Kg	Age, wear time	*F:* Q2vs.Q1 B = 0.00 (-0.62, 0.62), Q3vs.Q1 B = 0.69 (0.05, 1.34), Q4vs.Q1 B = 0.83 (0.11, 1.56) (p-trend<0.001)	p < 0.001
						1.28, 0.68), Q3vs.Q1 B = 1.00 (-0.03, 2.02), Q4vs.Q1 B=-0.01 (-1.14, 1.12) (p-trend = 0.03)	p = 0.03
	MVPA (quartiles: Q1=least MVPA)	Min/day	CST	#/min	Age, wear time	*F:* Q2vs.Q1 B = 1.54 (0.54, 2.55), Q3vs.Q1 B = 2.97 (1.93, 4.00), Q4vs.Q1 B = 3.61 (2.55, 4.67) (p-trend<0.001)	p < 0.001
						M: Q2vs.Q1 B = 1.69 (0.53, 2.84), Q3vs.Q1 B = 2.16 (0.98, 3.35), Q4vs.Q1 B = 2.43 (1.22, 3.64) (p-trend<0.001)	p < 0.001
	SB (quartiles: Q1=most SB)	H/day	CST	#/min	Age, wear time	*F:* Q2vs.Q1 B = 1.10 (0.09, 2.10), Q3vs.Q1 B = 1.53 (0.48, 2.57), Q4vs.Q1 B = 2.21 (1.03, 3.38) (p-trend = 0.003)	p = 0.003
						M: Q2vs.Q1 B = 1.36 (0.21, 2.51), Q3vs.Q1 B = 0.97 (-0.23,	p = 0.21

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Table C5 (*continued*)

Author year	Physical activity and sedentary behavior		Muscle strength and muscle power		Adjustment	Effect size (95% CI)[a]	p-value used for analyses[b]
	Reported measure (s)	Units	Reported measure(s)	Units			
						2.18), Q4vs.Q1 B = 1.25 (-0.06, 2.57) (p-trend = 0.21)	
Kim, 2015	Activity counts	#/min/day	HGS	Kg	Age, sex	Partial Rho = 0.081 (p = 0.251)	p = 0.251
	Activity counts	#/min/day	KES	N/kg	Age, sex	Partial Rho = 0.025 (p = 0.463)	p = 0.463
	Activity counts	#/min/day	5x CST	S	Age, BMI, morbidities + others	B=-0.272 (-0.456, -0.087)	p(calc) = 0.004
Kim et al., 2015	MVPA	% time/day	5x CST	S	Unadjusted	R=-0.400 (p < 0.001)	p < 0.001
	LPA	% time/day	5x CST	S	Unadjusted	R=-0.203 (0.01 < p < 0.05)	p(calc) = 0.042
	SB	% time/day	5x CST	S	Unadjusted	R = 0.292 (0.001 < p < 0.01)	p(calc) = 0.003
	Long SB bout	% time/day	5x CST	S	Unadjusted	R=-0.049 (p > 0.05)	p(calc) = 0.627
Lai et al., 2020	MVPA (Meeting vs. not meeting guidelines)	Min/day	5x CST (high vs. low)		Age, sex, BMI, edu + others	OR = 2.14 (0.79, 5.79)	p = 0.14
Lee et al., 2015	SB (quartiles: Q1=most SB)	%/day	5x CST	#/min	Age, sex, morbidities + others	Q2 vs Q1 B = 1.85 (SE = 0.90), Q3 vs Q1 B = 1.46 (SE = 0.96), Q4 vs. Q1 = B = 3.43 (SE = 0.98), (mean of Q2-Q4 vs Q1 p = 0.0016)	p = 0.0016
Lerma et al., 2018	MVPA	60 min/day	5x CST	% s	Age, sex	e^{β} =-4.433 (-7.21, -1.650)	p(calc) = 0.001
	LPA	60 min/day	5x CST	% s	Age, sex	e^{β} =-0.622 (-1.349, 0.104)	p(calc) = 0.093
	SB	60 min/day	5x CST	% s	Age, sex	e^{β} = 0.092 (-0.602, 0.786)	p(calc) = 0.807
Liao et al., 2018	SB	Min/day	HGS	Kg	Age, sex, MVPA + others	β=-0.083 (−0.199, 0.034)	p = 0.165
	SB break rate	#/sedentary h	HGS	Kg	Age, sex, MVPA, SB + others	β = 0.004 (−0.115, 0.124)	p = 0.944
	Long SB bouts	#/day	HGS	Kg	Age, sex, MVPA, SB + others	β = 0.053 (−0.132, 0.237)	p = 0.575
	Long SB bouts	Min/day	HGS	Kg	Age, sex, MVPA, SB + others	β=-0.060 (−0.159, 0.039)	p = 0.237
Lohne-Seiler et al., 2016	Steps	1000/day	HGS	Kg	Age, sex, wear time, test center	B=-1.33 (SE = 0.24) (-0.61, 0.34)	p = 0.6
Mador et al., 2011	VMU	#/min/day	KES	Kg	Unadjusted	*R = 0.50 (p = 0.013)	p = 0.013
Master et al., 2018	Steps	#/day	5x CST	S	Age, sex, morbidities + others	B=-130 (-178, -83)	p(calc)<0.001
Matkovic et al., 2020	Steps (<5000/day)	#/day	HGS	Kg	Unadjusted	*AUC = 0.596 (0.491, 0.702)	p = 0.082
	Steps (<5000/day)	#/day	30 s CST	#/30 s	Unadjusted	*AUC = 0.676 (0.576, 0.776)	p = 0.001
McDermott et al., 2002	Accelerations	#/day	5x CST	S	Unadjusted	*+PAD:* *B (NR) (+) (p-trend <0.0001)	p < 0.001
	Accelerations	#/day	5x CST	S	Unadjusted	*-PAD:* *B = N/R (+) (p-trend <0.0001)	p < 0.001
McGregor et al., 2018	MVPA	Log-ratio	HGS	Kg	Age, sex, morbidity + others	γ=-0.599 (p = 0.213)	p = 0.213
	LPA	Log-ratio	HGS	Kg	Age, sex, morbidity + others	γ = 2.979 (p = 0.028)	p = 0.028
	SB	Log-ratio	HGS	Kg	Age, sex, morbidity + others	γ = 0.003 (p = 0.677)	p = 0.677
	Steps	1000/day	HGS	Kg	Age, sex, BMI, edu + others	B = 0.01 (SE = 0.16), R^2 = 0.58	p = 0.53
Meier and Lee, 2020	Steps (high, medium, low)	#/day	Chest press strength	Lbs	Unadjusted	ANOVA (+) (p = 0.15) (+)	p = 0.15
	Steps (high, medium, low)	#/day	Leg press strength	Lbs	Unadjusted	ANOVA (+) (p = 0.17)	p = 0.17
Monteiro et al., 2019	Activity counts (terciles)	#/min/day	Arm curl	#/30 s	Unadjusted	ANOVA (+) (p = 0.058)	p = 0.058
	Activity counts (terciles)	#/min/day	KES	Nm	Unadjusted	ANOVA (+) (p = 0.060)	p = 0.060
	Activity counts (terciles)	#/min/day	Knee flexion strength	Nm	Unadjusted	ANOVA (+) (p = 0.051)	p = 0.051
	Activity counts (terciles)	#/min/day	30 s CST	#/30 s	Unadjusted	ANOVA (+) (p = 0.073)	p = 0.073
Morie et al., 2010	Activity counts (low vs. high)	10^{-5}/min/day	HGS	Kg	Unadjusted	T = N/R (p ≥ 0.36)	p ≥ 0.36
	Activity counts (low vs. high)	10^{-5}/min/day	Chest press strength	N	Unadjusted	T = N/R (p = 0.710)	p = 0.710
	Activity counts (low vs. high)	10^{-5}/min/day	Chest press power	W	Unadjusted	T = N/R (p = 0.945)	p = 0.945
	Activity counts (low vs. high)	10^{-5}/min/day	Leg press strength	N	Age, BMI, medications	β = 200, partial R^2 = 0.09 (p < 0.01)	p(calc) = 0.006
	Activity counts (low vs. high)	10^{-5}/min/day	Leg press power	W	Unadjusted	T = N/R (p = 0.359)	p = 0.359
Nagai et al., 2018	MVPA	Min/day	HGS (weak vs. not weak)	Kg	Unadjusted	Rpb=-0.12 (p < 0.05)	p(calc)<0.001
	LPA	Min/day		Kg	Unadjusted	Rpb=-0.16 (p < 0.05)	p(calc)<0.001

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Table C5 (*continued*)

Author year	Physical activity and sedentary behavior: Reported measure (s)	Units	Muscle strength and muscle power: Reported measure(s)	Units	Adjustment	Effect size (95% CI)[a]	p-value used for analyses[b]
			HGS (weak vs. not weak)				
	SB	Min/day	HGS (weak vs. not weak)	Kg	Unadjusted	Rpb = 0.14 (p < 0.05)	p(calc)<0.001
Nawrocka et al., 2017	MVPA (Meeting vs. not meeting guidelines)	Min/day	Arm curl	#/30 s	Unadjusted	Mann-Whitney U (+) (p = 0.587)	p = 0.587
	MVPA (Meeting vs. not meeting guidelines)	Min/day	30 s CST	#/30 s	Unadjusted	Mann-Whitney U (+) (p = 0.044)	p = 0.044
Nawrocka et al., 2019	MVPA (Meeting vs. not meeting guidelines)	Min/day	HGS	Kg	Unadjusted	Fischer's Exact (+) (p = 0.010)	p = 0.010
	MVPA (Meeting vs. not meeting guidelines)	Min/day	Arm curl	#/30 s	Unadjusted	Mann-Whitney U (+) (p = 0.004)	p = 0.004
	MVPA (Meeting vs. not meeting guidelines)	Min/day	30 s CST	#/30 s	Unadjusted	Mann-Whitney U (+) (p = 0.162)	p = 0.162
Nicolai et al., 2010	Steps *(Walking)*	Min/day	5x CST	S	Unadjusted	Rho=-0.398 (p = 0.008)	p = 0.008
	TPA (*Time on feet)*	Min/day	5x CST	S	Unadjusted	Rho=-0.460 (p = 0.002)	p = 0.002
Ofei-Doodoo et al., 2018	MVPA	Min/day	Arm curl	#/30 s	Unadjusted	R = 0.174 (p = 0.083)	p = 0.083
	MVPA	Min/day	30 s CST	#/30 s	Unadjusted	R = 0.388 (p = 0.000)	p(calc)<0.0001
Orwoll et al., 2019	MVPA *(MPA)*\	Min/day	5x CST	S	Unadjusted	R=-0.2 (p < 0.001)	p < 0.001
	LPA	Min/day	5x CST	S	Unadjusted	R=-0.2 (p < 0.001)	p < 0.001
Osuka et al., 2015	MVPA	Min/day	5x CST (low vs. high)	S	Unadjusted	*Mann-Whitney U (+) (p < 0.001)	p < 0.001
	LPA	Min/day	5x CST	S	Age, sex, BMI + others	β=-0.07 (p = 0.047)	p = 0.047
Park et al., 2018	Steps	#/day	HGS/weight	%	Unadjusted	R = 0.07 (p > 0.05)	p(calc) = 0.757
	TPA	Min/day	HGS/weight	%	Unadjusted	R = 0.10 (p > 0.05)	p(calc) = 0.658
	VPA	Min/day	HGS/weight	%	Unadjusted	R = 0.21 (p > 0.05)	
	MVPA	Min/day	HGS/weight	%	Unadjusted	R=-0.06 (p > 0.05)	p(calc) = 0.790
	MPA	Min/day	HGS/weight	%	Unadjusted	R=-0.07 (p > 0.05)	
	LPA	Min/day	HGS/weight	%	Unadjusted	R = 0.20 (p > 0.05)	p(calc) = 0.372
	SB	Min/day	HGS/weight	%	Unadjusted	R=-0.08 (p > 0.05)	p(calc) = 0.723
	Steps	#/day	30 s CST	#/30 s	Unadjusted	R = 0.36 (p > 0.05)	p(calc) = 0.100
	TPA	Min/day	30 s CST	#/30 s	Unadjusted	R = 0.25 (p > 0.05)	p(calc) = 0.262
	VPA	Min/day	30 s CST	#/30 s	Unadjusted	R = 0.05 (p > 0.05)	p(calc) = 0.190
	MVPA	Min/day	30 s CST	#/30 s	Unadjusted	R = 0.29 (p > 0.05)	
	MPA	Min/day	30 s CST	#/30 s	Unadjusted	R = 0.29 (p > 0.05)	p(calc) = 0.860
	LPA	Min/day	30 s CST	#/30 s	Unadjusted	R = 0.04 (p > 0.05)	p(calc) = 0.791
	SB	Min/day	30 s CST	#/30 s	Unadjusted	R = 0.06 (p > 0.05)	
Perkin et al., 2018	MVPA	Min/day	Leg press strength	N	Unadjusted	R^2=N/R (p > 0.05)	p(N/R)>0.25
	SB	Min/day	Leg press strength	N	Unadjusted	R^2=N/R (p > 0.05	p(N/R)>0.25
	EE *(PAL)*	None	Leg press strength	N	Unadjusted	R^2=-0.03 (p > 0.05)	p(calc) = 0.230
	MVPA	Min/day	Leg press power	W	Unadjusted	R^2=N/R (p > 0.05)	p(N/R)>0.25
	SB	Min/day	Leg press power	W	Unadjusted	R^2=N/R (p > 0.05)	p(N/R)>0.25
	EE *(PAL)*	None	Leg press power	W	Unadjusted	R^2=-0.03 (p > 0.05)	p(calc) = 0.230
Pitta et al., 2005	Steps *(Walking)*	Min/day	HGS	%pred	Unadjusted	R = 0.44 (0.001 < p < 0.01)	0.001 < p < 0.01
	TPA *(Standing)*	Min/day	HGS	%pred	Unadjusted	R = 0.28 (0.01 < p ≤ 0.5)	0.01 < p ≤ 0.5
	Steps *(Walking)*	Min/day	KES	%pred	Unadjusted	R = 0.45 (0.001 < p < 0.01)	0.001 < p ≤ 0.1
	TPA *(Standing)*	Min/day	KES	%pred	Unadjusted	R = 0.20 (p > 0.5)	p(calc) = 0.164
Puthoff et al., 2008	Steps	#/day	Leg press strength	N/kg	Unadjusted	*B = 184.15 (SE = 107.86) β = 0.31	p(calc) = 0.087
	Steps	#/day	Leg press power (peak)	W/kg	Unadjusted	*B = 340.99 (SE = 152.08) β = 0.40	p(calc) = 0.024
	Steps	#/day	Leg press power (40%)	W/kg	Unadjusted	*B = 237.41 (SE = 160.68) β = 0.29	p(calc) = 0.140
	Steps	#/day	Leg press power (90%)	W/kg	Unadjusted	*B = 351.73 (SE = 175.81) β = 0.36	p(calc) = 0.045
Rapp et al., 2012	Steps (*Walking)*	Min/day	HGS	Kg	Unadjusted	**M 65-74y*: B=-0.2 (-0.7, 0.3)	p(calc) = 0.441
						**M 75-90y*: B=-0.05 (-0.5, 0.4)	p(calc) = 0.839
						**F 65-74y*: B = 0.3 (-0.4, 0.9)	p(calc) = 0.372
						**F 75-90y*: B = 1.5 (0.7, 2.3)	p(calc)<0.001
	Steps (*Walking)*	Min/day	5x CST	S	Unadjusted	**M:* β=-2.4 (-3.3, -1.6)	p(calc)<0.001
						**F:* β=-3.2 (-4.0, -2.4)	p(calc)<0.001
Rausch-Osthoff et al., 2014	Steps	#/day	KES	Nm	Unadjusted	*β=-0.085 (-0.567, 0.387)	p = 0.699
	EE	Kcal/day	KES	Nm	Unadjusted	*β = 0.274 (-0.171, 0.749)	p = 0.206
	EE *(PAL)*	None	KES	Nm	Unadjusted	*β = 0.092 (-0.345, 0.516)	
	MET	Kcal/day/kg	KES	Nm	Unadjusted	*β = 0.100 (-0.371, 0.582)	p = 0.650
Rava et al., 2018	VPA	Min/day	5x CST	S	Age, BMI	R=-0.06 (p > 0.00625)	

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Table C5 (*continued*)

Author year	Physical activity and sedentary behavior		Muscle strength and muscle power		Adjustment	Effect size (95% CI)[a]	p-value used for analyses[b]
	Reported measure (s)	Units	Reported measure(s)	Units			
Reid et al., 2018	MVPA	Min/day	5x CST	S	Age, BMI	R=-0.27 (p > 0.00625)	p(calc) = 0.015
	MPA	Min/day	5x CST	S	Age, BMI	R=-0.26 (p > 0.00625)	
	LPA	Min/day	5x CST	S	Age, BMI	R=-0.12 (p > 0.00625)	p(calc) = 0.286
	SB	Min/day	5x CST	S	Age, BMI	R = 0.05 (p > 0.00625)	p(calc) = 0.658
	SB	#/day	KES	Kg	Age, sex	RR = 1.02 (0.93, 1.12)	p(calc) = 0.689
	BST	10/day	KES	Kg	Age, sex	RR = 0.94 (0.82, 1.07)	p(calc) = 0.368
	SB	#/day	Leg press strength	Kg	Age, sex	B = 1.61 (-2.33, 5.56)	p(calc) = 0.432
	BST	10/day	Leg press strength	Kg	Age, sex	B=-6.32 (-11.95, -0.69)	p(calc) = 0.028
	SB	#/day	30 s CST	#/30 s	Age, sex	B=-0.28 (-0.51, -0.04)	p(calc) = 0.019
	BST	10/day	30 s CST	#/30 s	Age, sex	B = 0.10 (-0.24, 0.45)	p(calc) = 0.259
Rojer et al., 2018	Steps	1000/day	HGS (Z-score)	SD	Age, sex	B = 0.052(SE = 0.038)	p = 0.173
	TPA	Min/day	HGS (Z-score)	SD	Age, sex	B = 0.002 (SE = 0.001)	p = 0.279
	SB	H/day	HGS (Z-score)	SD	Age, sex	B=-0.091 (SE = 0.081)	p = 0.267
	PA bouts	100/day	HGS (Z-score)	SD	Age, sex	B = 0.027 (SE = 0.022)	p = 0.231
	PA bouts	S/bout/day	HGS (Z-score)	SD	Age, sex	B=-0.023 (SE = 0.043)	p = 0.594
	SB bouts	100/day	HGS (Z-score)	SD	Age, sex	B = 0.219 (SE = 0.243)	p = 0.370
	SB bouts	H/bout/day	HGS (Z-score)	SD	Age, sex	B=-0.041 (SE = 0.035)	p = 0.254
Rosenberg et al., 2015	SB	H/day	5x CST	S	Age, sex, MVPA + others	B = 1.02 (SE = 0.21)	p < 0.001
Rowlands et al., 2018	MVPA	Min/day	HGS	Kg	Age, sex, body fat + others	B = 0.02 (-0.02, 0.06)	p(calc) = 0.332
	Accelerations	Mg-force	HGS	Kg	Age, sex, body fat + others	B = 0.09 (-0.04, 0.23)	p(calc) = 0.193
	Intensity gradient	N/R	HGS	Kg	Age, sex, body fat + others	B = 4.44 (0.60, 8.27)	p(calc)<0.001
	PA bouts	Min/day	HGS	Kg	Age, sex, body fat + others	B=-0.01 (-0.07, 0.05)	p(calc) = 0.757
	MVPA	Min/day	60 s CST	#/60 s	Age, sex, body fat + others	B = 0.06 (0.02, 0.09)	p(calc)<0.001
	Accelerations	Mg-force	60 s CST	#/60 s	Age, sex, body fat + others	B = 0.25 (0.11, 0.40)	p(calc) = 0.007
	Intensity gradient	N/R	60 s CST	#/60 s	Age, sex, body fat + others	B = 8.83 (5.83, 11.83)	p(calc)<0.001
	PA bouts	Min/day	60 s CST	#/60 s	Age, sex, body fat + others	B = 0.07 (-0.02, 0.16)	p(calc) = 0.127
Safeek et al., 2018	Steps	#/day	HGS	Kg	Unadjusted	R=-0.02 (p > 0.05)	p(calc) = 0.931
	MVPA	Min/day	HGS	Kg	Unadjusted	R=-0.20 (p > 0.05)	p(calc) = 0.385
	LPA	H/day	HGS	Kg	Unadjusted	R = 0.15 (p > 0.05)	p(calc) = 0.516
	SB	H/day	HGS	Kg	Unadjusted	R = 0.15 (p > 0.05)	p(calc) = 0.516
	EE	Kcal/day	HGS	Kg	Unadjusted	R = 0.12 (p > 0.05)	p(calc) = 0.604
	Steps	#/day	30 s CST	#/30 s	Unadjusted	R = 0.30 (p > 0.05)	p(calc) = 0.186
	MVPA	Min/day	30 s CST	#/30 s	Unadjusted	R = 0.16 (p > 0.05)	p(calc) = 0.488
	LPA	H/day	30 s CST	#/30 s	Unadjusted	R = 0.24 (p > 0.05)	p(calc) = 0.295
	SB	H/day	30 s CST	#/30 s	Unadjusted	R=-0.25 (p > 0.05)	p(calc) = 0.274
	EE	Kcal/day	30 s CST	#/30 s	Unadjusted	R = 0.16 (p > 0.05)	p(calc) = 0.488
Sánchez-Sánchez et al., 2019	Activity counts	SDs (#/day)	HGS	Kg	Age residuals, sex + others	B = 0.857 (0.312, 1.402)	0.001 < p < 0.01
	MVPA	H/day	HGS	Kg	Age residuals, sex + others	B = 0.933 (0.246, 1.620)	0.001 < p < 0.01
	LPA	H/day	HGS	Kg	Age residuals, sex + others	B = 0.428 (0.051, 0.805)	p(calc) = 0.026
	SB	H/day	HGS	Kg	Age residuals, sex + others	B=-0.467 (-0.807, -0.128)	p(calc) = 0.007
Santos et al., 2012	MVPA	Min/day	Arm curl	#/30 s	Age, sex, register time	B = 0.016 (-0.007, 0.039)	p(calc) = 0.173
	SB	Min/day	Arm curl	#/30 s	Age, sex, register time	B=-0.010 (-0.016, -0.004)	p(calc)<0.001
	MVPA	Min/day	30 s CST	#/30 s	Age, sex, register time	B = 0.035 (0.014, 0.055)	p(calc)<0.001
	SB	Min/day	30 s CST	#/30 s	Age, sex, register time	B=-0.013 (-0.018, -0.008)	p(calc)<0.001
Sardinha et al., 2015	BST BST	#/day #/day	Arm curl 30 s CST	#/30 s #/30 s	Age, sex, BMI, SB + others Age, sex, BMI, SB + others	β = 0.180 (0.039, 0.322) β = 0.181 (0.045, 0.318)	p(calc) = 0.013 p (calc) = 0.797
Scott et al., 2020	MVPA	H/day	HGS (low vs. high)	Kg	Sex, BMI, LPA, SB + others	OR = 0.80 (0.71, 0.91)	p(calc)<0.001
	LPA	H/day	HGS (low vs. high)	Kg	Sex, BMI, MVPA, SB + others	OR = 0.99 (0.96, 1.02)	p(calc) = 0.526
	SB	H/day	HGS (low vs. high)	Kg	Sex, BMI, MVPA, LPA + others	OR = 1.00 (0.98,1.02)	p(calc) = 1
Scott et al., 2011	Steps (*baseline*)	#/day x 10^3	ΔLeg strength	Kg	Age, weight, CVD + others	*M:* B=-0.28 (-1.27, 0.72)	p(calc) = 0.593
						F: B = 1.06 (0.31, 1.31)	
	Steps (*habitual*)	#/day x 10^3	ΔLeg strength	Kg		*M:* B=-0.21 (-1.24, 0.82)	p(calc)<0.001

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Table C5 (*continued*)

Author year	Physical activity and sedentary behavior		Muscle strength and muscle power		Adjustment	Effect size (95% CI)[a]	p-value used for analyses[b]
	Reported measure (s)	Units	Reported measure(s)	Units			
					Age, weight, CVD + others		
						F: B = 1.37(0.57, 2.17)	
Scott et al., 2009	Steps	#/day	Leg strength	Kg	Age	*M:* B = 0.86 (-0.02, 1.74)	p = 0.056
	Steps	#/day	Leg strength	Kg	Age	*F:* B = 071 (0.13, 1.29)	p = 0.016
Semanik et al., 2015	SB	H/day	Δ5x CST	#/min	Age, sex, baseline CST + others	B=-0.58 (-0.92, -0.24)	p < 0.001
Silva et al., 2019	MVPA	Min/day	Arm curl	#/30 s	Unadjusted	Rho = 0.243 (p = 0.027)	p = 0.027
	LPA	Min/day	Arm curl	#/30 s	Unadjusted	Rho=-0.069 (p = 0.538)	p = 0.538
	SB	Min/day	Arm curl	#/30 s	Unadjusted	Rho = 0.124 (p = 0.264)	p = 0.264
	MVPA	Min/day	30 s CST	#/30 s	Unadjusted	Rho = 0.163 (p = 0.142)	p = 0.142
	LPA	Min/day	30 s CST	#/30 s	Unadjusted	Rho=-0.083 (p = 0.458)	p = 0.458
	SB	Min/day	30 s CST	#/30 s	Unadjusted	Rho = 0.167 (p = 0.131)	p = 0.131
Spartano et al., 2019	Steps	1000/day	HGS	Kg	Age, sex, wear time + others	*M:* B=-0.16 (SE = 0.09)	p = 0.077
						F; B = 0.09 (SE = 0.06)	p = 0.125
	MVPA	Log(min/ day)	HGS	Kg	Age, sex, wear time + others	*M:* B = 0.058 (SE = 0.34)	p = 0.090
						F: B = 0.64 (SE = 0.19)	p = 0.0008
	SB	% wear time	HGS	Kg	Age, sex, wear time + others	*M:* B = 0.09 (SE = 0.05)	p = 0.088
						F: B=-0.05 (SE = 0.04)	p = 0.133
	Steps	1000/day	5x CST	Log(s)	Age, sex, wear time + others	B=-0.010 (SE = 0.002)	p < 0.0001
	MVPA	Log(min/ day)	5x CST	Log(s)	Age, sex, wear time + others	B=-0.057 (SE = 0.006)	p < 0.0001
	SB	% wear time	5x CST	Log(s)	Age, sex, wear time + others	B = 0.006 (SE = 0.001)	p < 0.0001
Tang et al., 2015	Activity counts	#/day	HGS	Kg	SPPB score, 6 min walk test	*B = 23022 (-41988, -4055)	p = 0.02
Trayers et al., 2014	Steps (low vs. high)	#/day	5x CST (0-4)	Points	Age, sex	*OR = 7.2 (3.8, 13.6)	p < 0.001
	Activity counts (low vs. high)	#/day	5x CST (0-4)	Points	Age, sex	*OR = 5.8 (3.2, 10.8)	p < 0.001
	MVPA (low vs. high)	Min/day	5x CST (0-4)	Points	Age, sex	*OR = 7.8 (4.0, 15.0)	p < 0.001
Van Gestel et al., 2012	Steps	#/day	HGS	Kg	Unadjusted	R = 0.21 (-0.03, -0.42)	p = 0.19
	Steps	#/day	60 s CST	#/60 s	BMI, partial pressure O^2, FEV_1	*B = 155.38 (SE = 73.15) β = 0.28	p = 0.041
Van Lummel et al., 2016	TPA *(standing)*	Min/day	5x CST (fast vs. slow)	S	Unadjusted	*Mann-Whitney U (+) (p = 0.230)	p = 0.230
	PA bouts	#/day	5x CST (fast vs. slow)	S	Unadjusted	*Mann-Whitney U (+) (p = 0.218)	p = 0.218
	SB bouts	Min/bout/ day	5x CST (fast vs. slow)	S	Unadjusted	*Mann-Whitney U (-) (p = 0.042)	p = 0.042
van Oeijen et al., 2020	ΔSteps	#/day	ΔLower extremity muscle strength	Z-score	Unadjusted	B = 676.279 (SE = 186.151)	p < 0.000
Van Sloten et al., 2011	Steps	#/day	HGS (low vs. high)	Kg	Age, sex, BMI, neuropathy, PAD	*B=-1782 (-3348, -217)	p(calc) = 0.025
Walker et al., 2008	TPA	% time/day	KES	N	Unadjusted	R = 0.4 (0.06, 0.55)	p = 0.023
Ward et al., 2014	Activity counts	#/min/day	30 s CST	#/30 s	Age, sex, morbidities, body fat	β = 0.002 (-0.006, 0.009)	p(calc) = 0.614
	MVPA	Min/week	30 s CST	#/30 s	Age, sex, morbidities	Partial R = 0.147 (p > 0.05)	p(calc) = 0.067
Waschki et al., 2012	Steps	#/day	KES	Kg	Age, sex, BMI, study site	β = 0.298 (p = 0.022)	p = 0.022
	EE *(PAL)*	None	KES	Kg	Age, sex, BMI, study site	β = 0.350 (p = 0.007)	p = 0.007
Watz et al., 2008	Steps	#/day	HGS	Kg	Edu, smoking, alcohol + others	N/R (p > 0.05)	p(N/R)>0.25
	EE *(PAL)*	None	HGS	Kg	Edu, smoking, alcohol + others	N/R (p > 0.05)	p(N/R)>0.25
Westbury et al., 2018	TPA	Min/day	HGS	Kg	Age, sex, height + others	β = 0.16 (-0.03, 0.34)	p = 0.09
	MVPA	Min/day	HGS	Kg	Age, sex, height + others	β = 0.11 (-0.09, 0.31)	p = 0.27
	Accelerations	Mg-force	HGS	Kg	Age, sex, height + others	β = 0.12 (-0.07, 0.30)	p = 0.23
Wickerson et al., 2013	Steps	#/day	Knee extension torque	Nm	Unadjusted	R = 0.51 (p < 0.01)	p(calc) = 0.011
	MVPA	Min/day	Knee extension torque	Nm	Unadjusted	R = 0.36 (p = 0.08)	p = 0.08

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Table C5 (*continued*)

Author year	Physical activity and sedentary behavior		Muscle strength and muscle power		Adjustment	Effect size (95% CI)[a]	p-value used for analyses[b]
	Reported measure (s)	Units	Reported measure(s)	Units			
Winberg et al., 2015	Steps	#/day	KES	Nm	Age, sex, BMI	*B = 19 (p < 0.01), R^2 = 0.18	p(calc)<0.001
	Steps	#/day	Knee flexion strength	Nm	Age, sex, BMI	*B = 39 (p < 0.01), R^2 = 0.19	p(calc)<0.001
Yamada et al., 2011	Steps	#/day	5x CST	S	Age, sex, gait speed + others	β=-0.147 (p < 0.01)	p(calc)<0.001
Yasunaga et al., 2017	MVPA	10 min/day	HGS	Kg	Age, sex, morbidities + others	B = 0.092 (-0.135, 0.318)	p(calc) = 0.434
	LPA	10 min/day	HGS	Kg	Age, sex, morbidities + others	B = 0.058 (-0.024, 0.141)	p(calc) = 0.169
	SB	10 min/day	HGS	Kg	Age, sex, morbidities + others	B=-0.056 (-0.130, 0.017)	p(calc) = 0.136
Yoshida et al., 2010	Steps	#/day	HGS	Kg	Unadjusted	*HFG:* Rho = 0.137 (p > .05) *LFG:* Rho = 0.142 (p > .05)	p(calc) = 0.301 p(calc) = 0.187
	TPA	Min/day	HGS	Kg	Unadjusted	*HFG:* Rho=-0.091 (p > .05) *LFG:* Rho = 0.102 (p > .05)	p(calc) = 0.493 p(calc) = 0.344
	MVPA (*MPA)*	Min/day	HGS	Kg	Unadjusted	*HFG:* Rho = 0.206 (p > .05) *LFG:* Rho = 0.146 (p > .05)	p(calc) = 0.118 p(calc) = 0.175
	LPA	Min/day	HGS	Kg	Unadjusted	*HFG:* Rho=-0.176 (p > .05) *LFG:* Rho = 0.076 (p > .05)	p(calc) = 0.182 p(calc) = 0.482
	Steps	#/day	KES	Nm	Unadjusted	*HFG:* Rho = 0.277 (p < .05) *LFG:* Rho=-0.018(p > .05)	p(calc) = 0.034 p(calc) = 0.868
	TPA	Min/day	KES	Nm	Unadjusted	*HFG:* Rho=-0.159 (p > .05) *LFG:* Rho=-0.034 (p > .05)	p(calc) = 0.229 p(calc) = 0.753
	MVPA (*MPA)*	Min/day	KES	Nm	Unadjusted	*HFG:* Rho = 0.475 (p < .01) *LFG:* Rho = 0.055 (p > .05)	p(calc)<0.001 p(calc) = 0.677
	LPA	Min/day	KES	Nm	Unadjusted	*HFG:* Rho = 0.028 (p > .05) *LFG:* Rho=-0.045 (p > .05)	p(calc) = 0.833 p(calc) = 0.611
Yuki et al., 2019	Steps	#/day	HGS (weakness vs. no weakness)	Kg	Age, sex	*OR = N/R (p > 0.05)	p(N/R)>0.25
	LPA	Min/day	HGS weakness vs. no weakness)	Kg	Age, sex	*OR = N/R (p > 0.05)	p(N/R)>0.25
	MVPA	Min/day	HGS weakness vs. no weakness)	Kg	Age, sex	*OR = N/R (p > 0.05)	p(N/R)>0.25

TPA = total physical activity, MPA = moderate physical activity, VPA = vigorous physical activity, MVPA = moderate to vigorous physical activity, LPA = light physical activity, SB = sedentary behavior, EE = energy expenditure, PAL = physical activity units, BST = breaks in sedentary time, Δ=change, MET = metabolic equivalent of tasks, VMU = vector magnitude units, min = minutes, h = hours, CPM = counts per minutes, #=number, mg-force = miligrams-force (force of earth gravity acting on one milligram), SD = standard deviation, log = log transformed, e = natural log, Partial R = partial correlation, R = Pearson's correlation, Rho = Spearman's correlation, R_{pb}=point biserial correlation, B = unstandardized regression coefficient (unstandardized beta), β=standardized regression coefficient (standardized beta), RR = relative risk, OR = odds ratio, Partial η^2= partial eta squared, ANOVA = analysis of variance, EMM = estimated marginal means, T = t-test (t-statistic), Q = quartile, p-trend = p for trend, HGS = hand grip strength, KES = knee extension strength, KET = knee extension torque, CST = chair stand test, s = seconds, x = times (repetitions), #=number, quad = quadriceps, kg = kilogram, N = newton, Nm = newton-meter, W = watt, KgF = kilogram-force, KiloW = kilowatt, KiloN = kilonewton, MVC = maximum voluntary contraction, 1RM = one repetition maximum, Lbs = pounds, max = maximum, / = divided by or per, Δ=change, %pred=% predictive, +/- = with or without, N/A = not applicable, N/R = not reported, M = male, F = female, HFG = high functioning group, LFG = low functioning group, BMI = body mass index, OA = osteoarthritis, O^2=oxygen, FEV = forced expirator volume in one second in percent of predicted, + others = adjusted for other potential confounders.

[a] If effect sizes were not reported, when possible, the direction of effect was determined as either positive (+) when higher PA and lower SB was associated with better muscle strength/power or as negative (-) when associated with worse muscle strength/power. *Stars before effect size coefficient represent the use of muscle strength or muscle power as an independent variable and PA or SB as the dependent variable, all other associations presented describe PA and SB as independent variable and muscle strength and power as the dependent variable.

[b] p-values of associations included in analyses (effect direction heat map and albatross plots) are presented as reported in article, calculated as p(calc) using formulas described in methods, or estimated conservatively as p (N/R) when p-value was not reported and could not be calculated (estimation described in methods). Associations with a blank space for p-value were not included as exposure-outcome associations were only represented once per article. If two articles reported the same exposure-outcome (PA/SB – muscle strength/power) association in the same population, adjusted data was used based on hierarchy of adjustment models or when adjustment models were the same, the data from the article with a larger sample sized was used and indicated by "author year". Underlined articles have a longitudinal design.

Appendix D

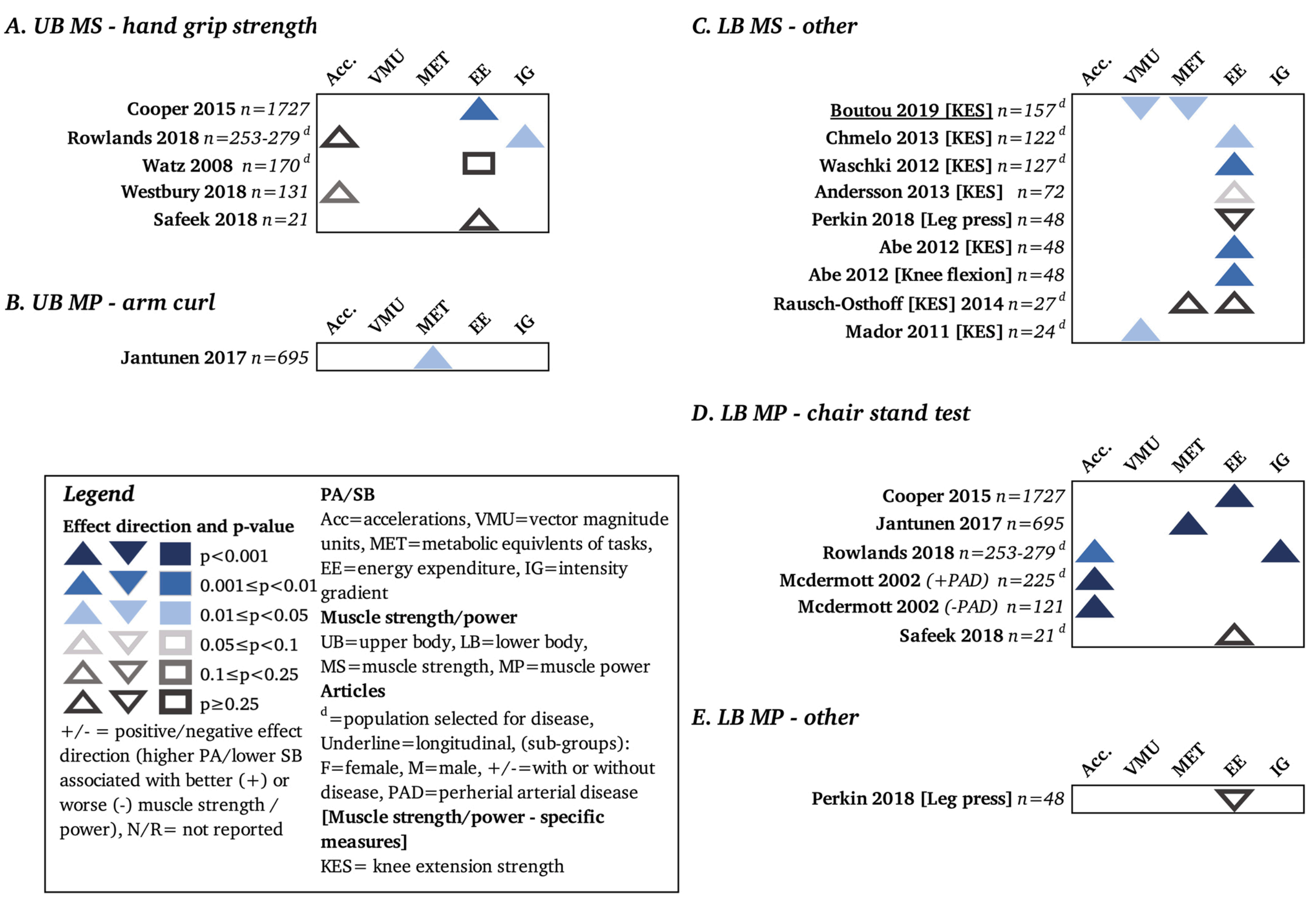

Fig. D1. Effect direction heat maps of the associations between intensity-based accelerometer measures of physical activity with upper body (A, B) and lower body (C, D, E) measures of muscle strength and muscle power.

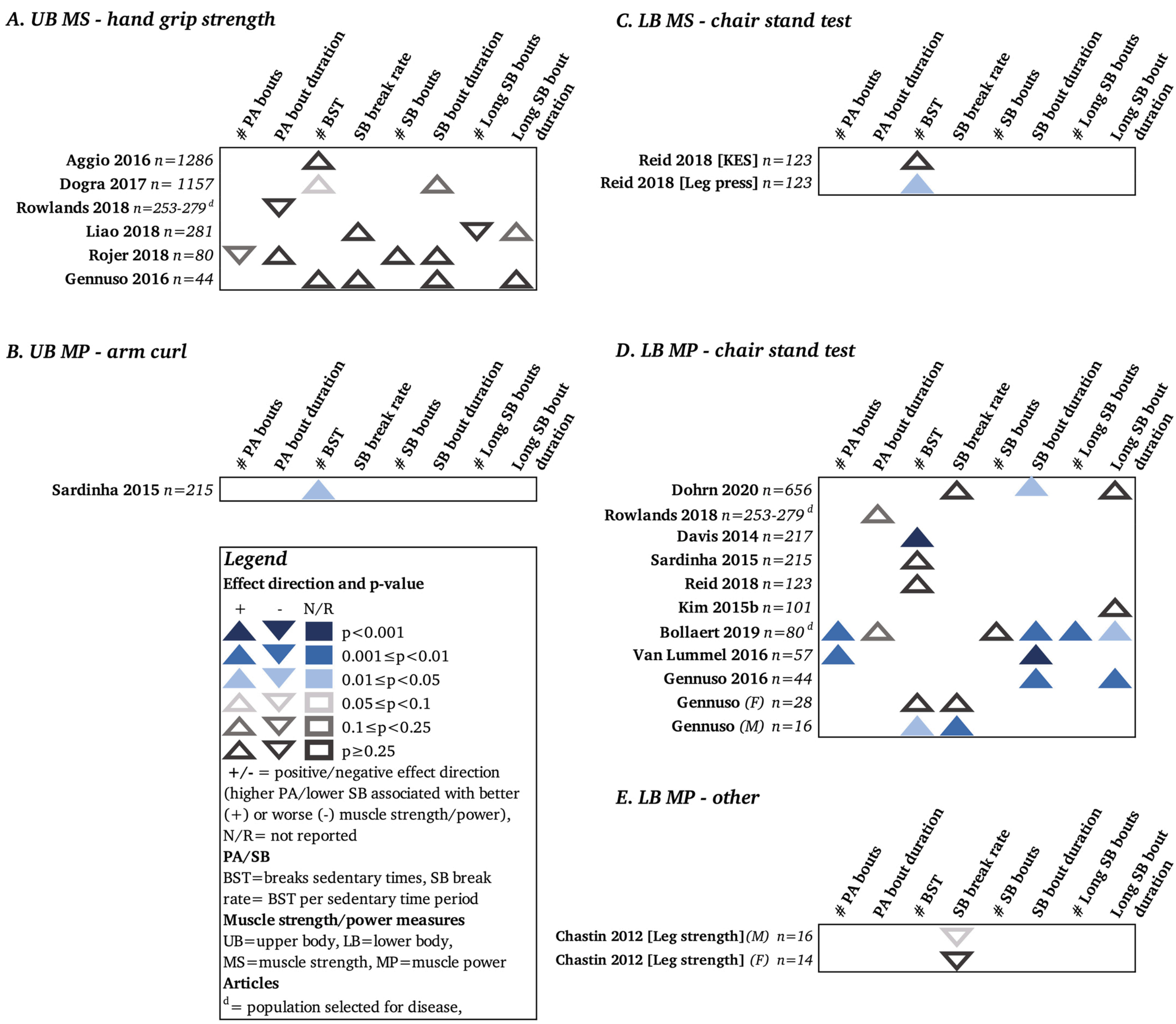

Fig. D2. Effect direction heat maps of the associations between physical activity and sedentary behavior frequency and accumulation with upper (A, B) and lower body (C, D) measures of muscle strength and muscle power.

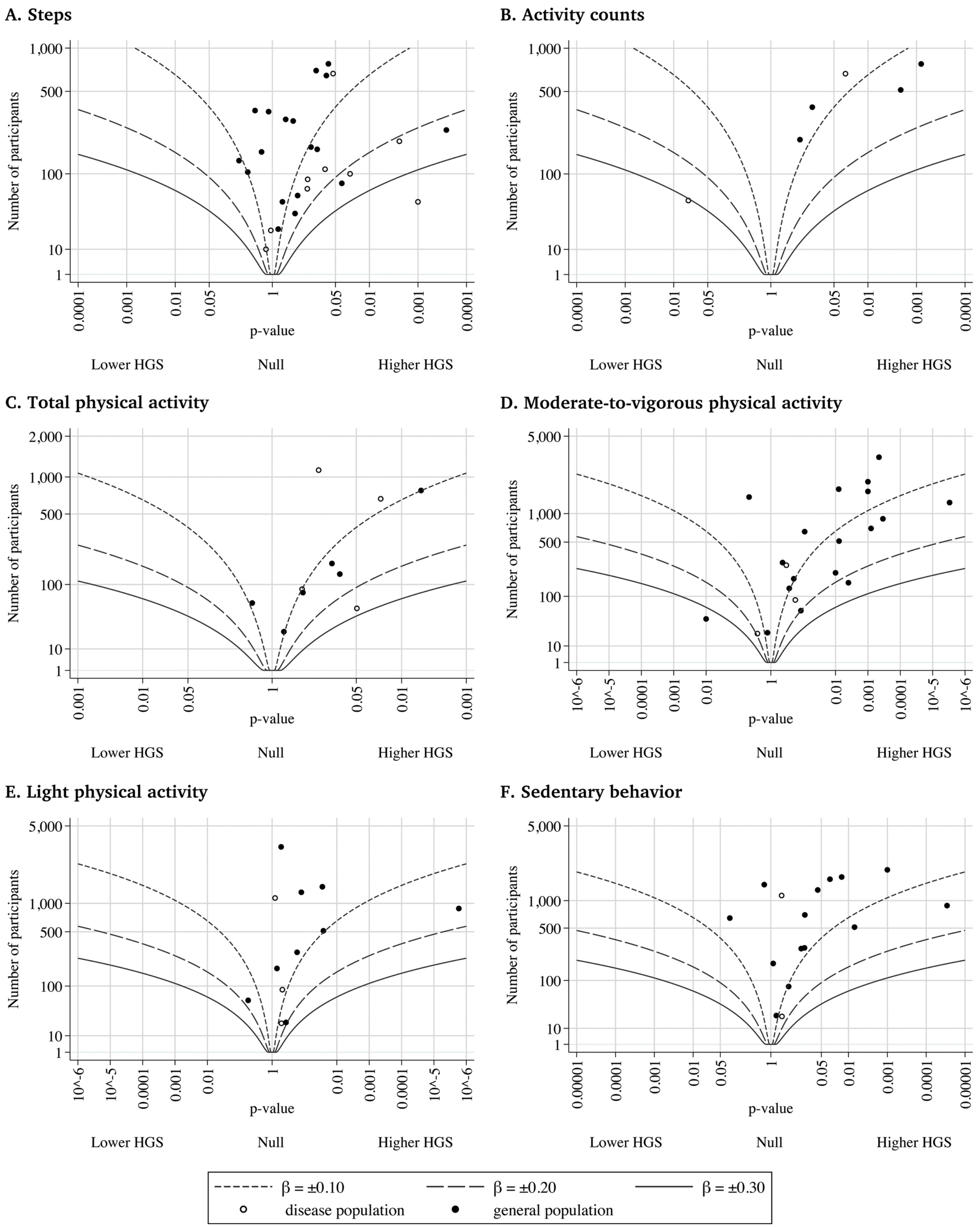

Fig. D3. Albatross plots depicting the magnitude of the association (contours lines represent standardized regression coefficients (β)) of higher physical activity measures (A, B, C, D, E) or lower sedentary behavior (F) with hand grip strength (upper body muscle strength).

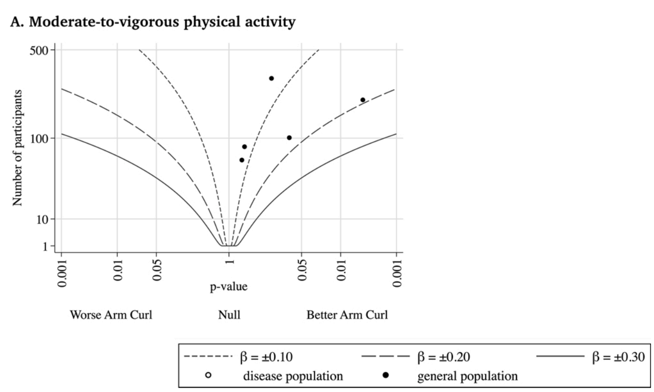

Fig. D4. Albatross plots depicting the magnitude of the association (contours lines represent standardized regression coefficients (β)) of higher moderate-to-vigorous physical activity (A) with arm curl (upper body muscle power).

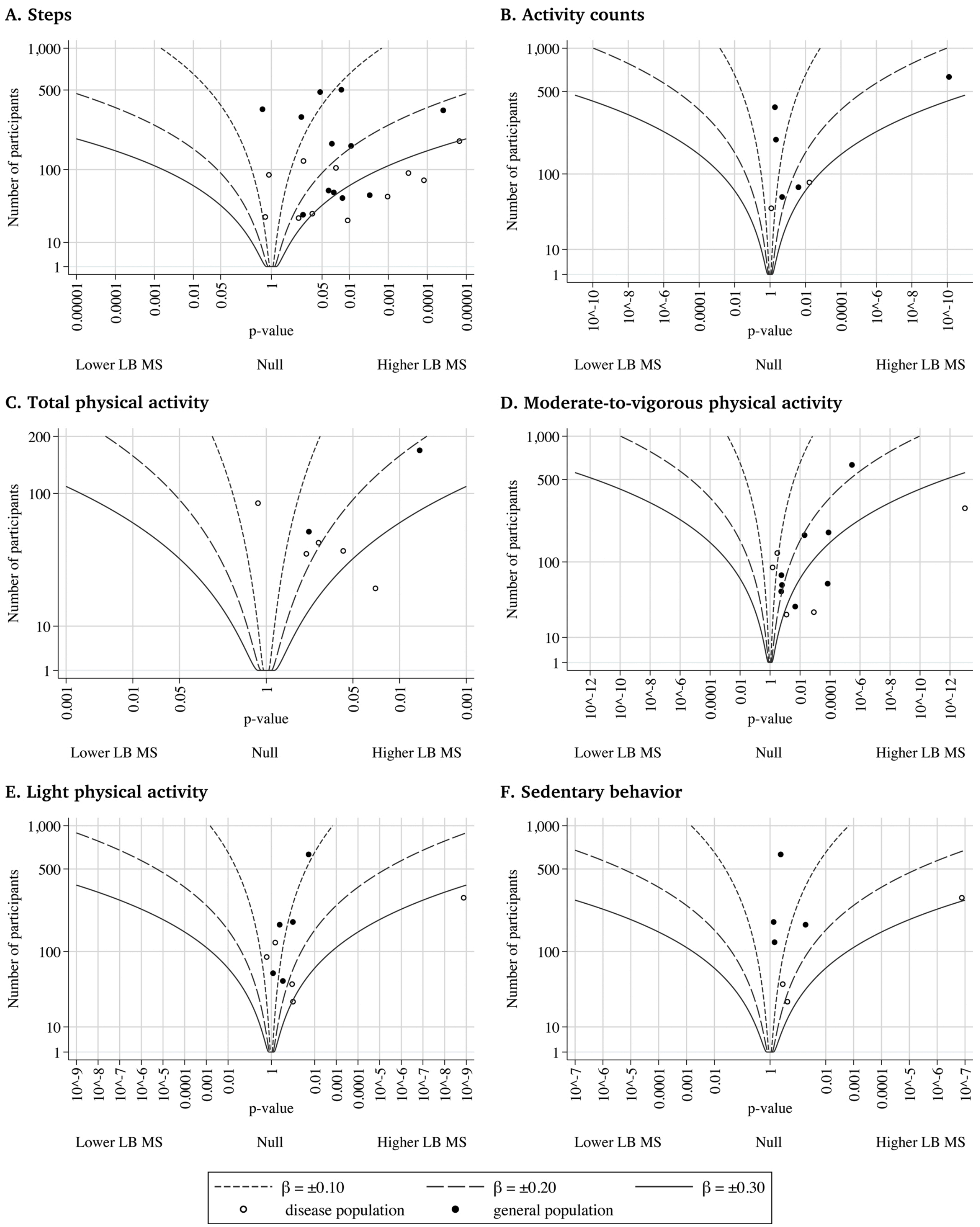

Fig. D5. Albatross plots depicting the magnitude of the association (contours lines represent standardized regression coefficients (β)) of higher physical activity measures (A, B, C, D, E) or lower sedentary behavior (F) with lower body muscle strength.

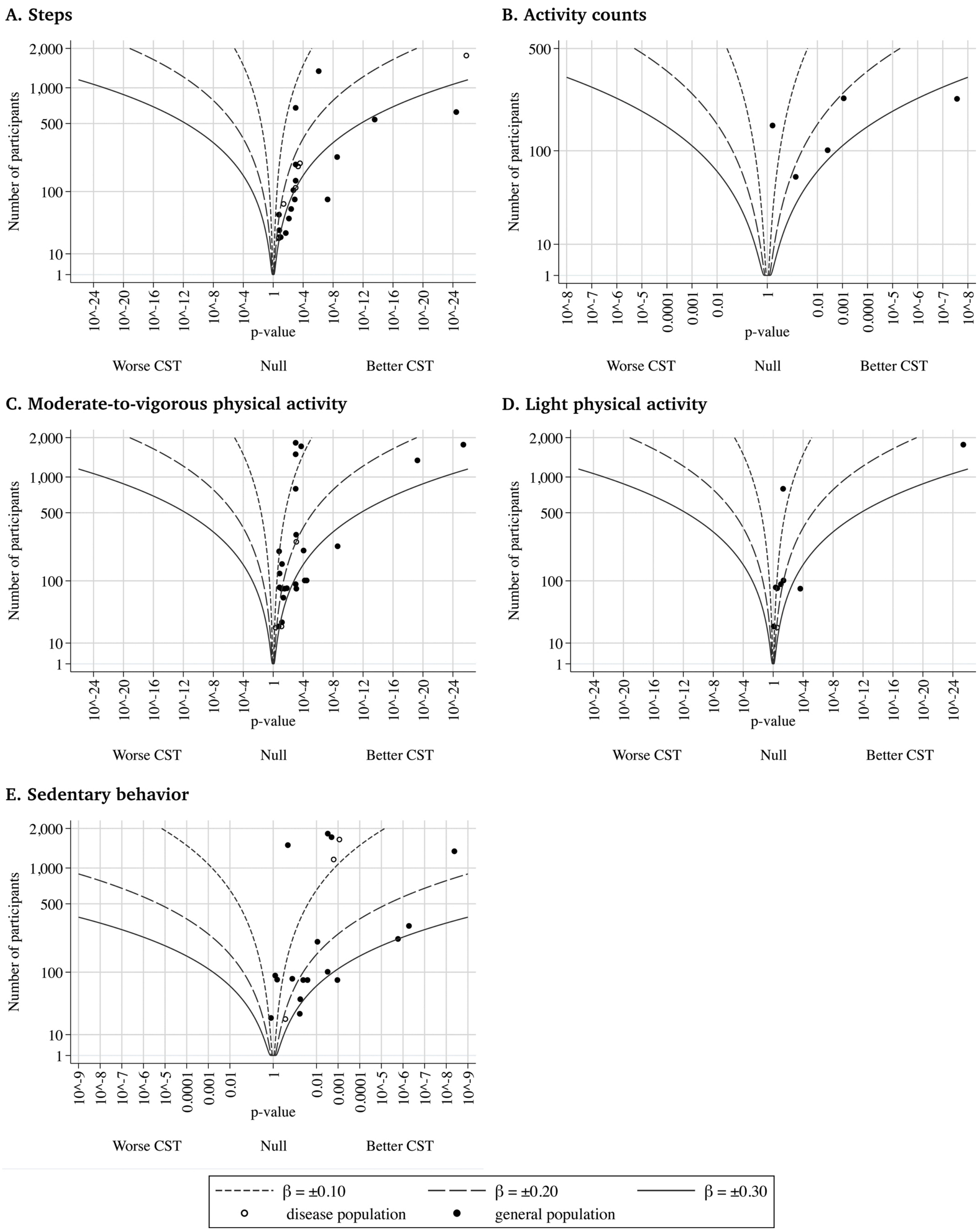

Fig. D6. Albatross plots depicting the magnitude of the association (contours lines represent standardized regression coefficients (β)) of higher physical activity measures (A, B, C, D) or lower sedentary behavior (E) with chair stand test (lower body muscle power).

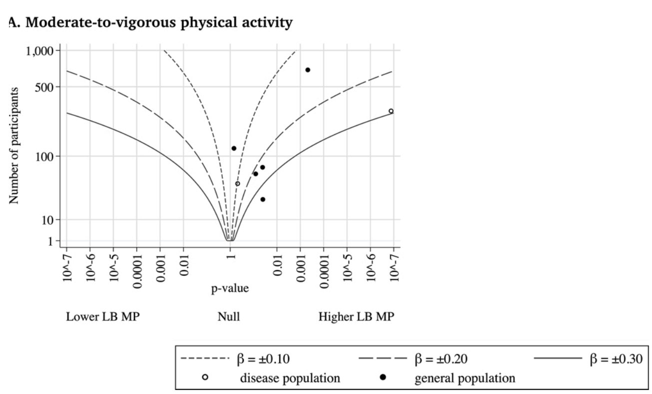

Fig. D7. Albatross plots depicting the magnitude of the association (contours lines represent standardized regression coefficients (β)) of higher moderate-to-vigorous physical activity (A) with lower body muscle power.

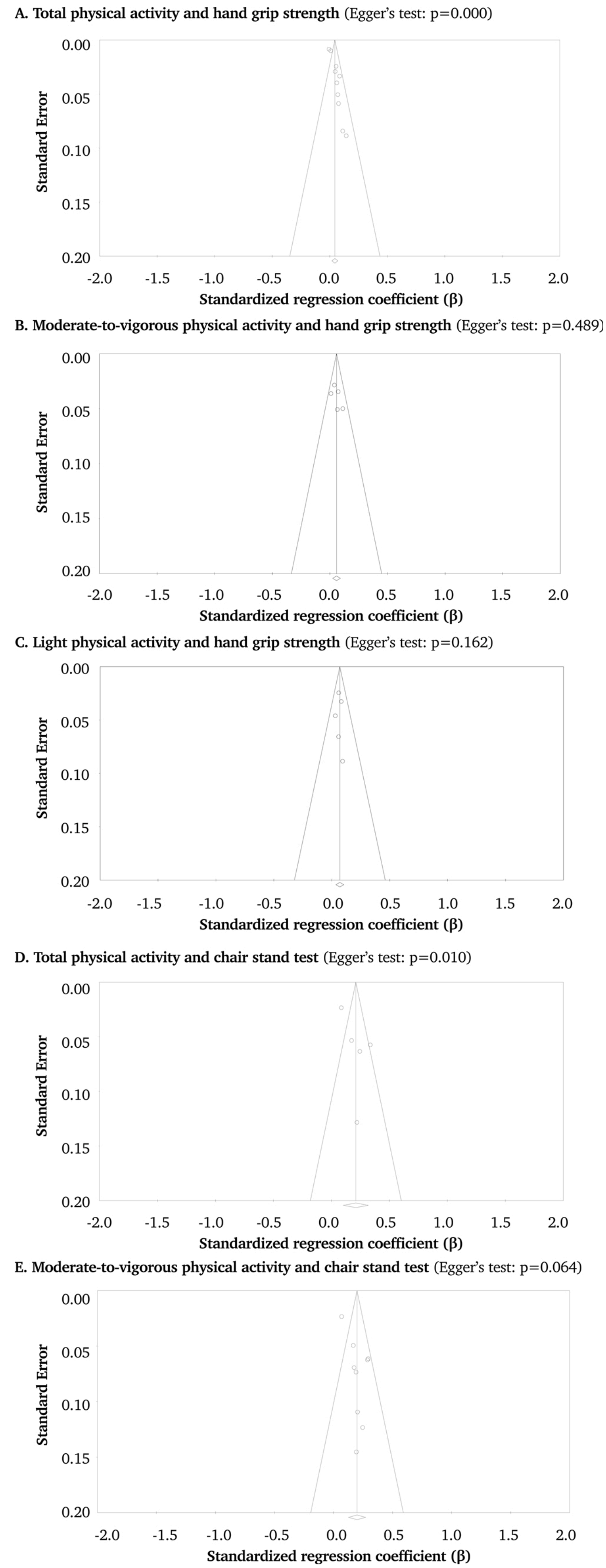

Fig. D8. Funnel plots of standard errors by standardized regression coefficients (β) for the associations of physical activity measures with hand grip strength (A, B, C) and chair stand test (D, E), respectively.

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