



Physical activity – life course trajectories and patterns of strength in the UK

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Executive Summary

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Background and context

Strength is a priority public health recommendation by the [UK Chief Medical Officers](#) in their physical activity guidelines for people of all age groups, however it is of particular importance for mid-later life age groups. We received a request from DHSC to examine patterns of strength across the life course and identify an optimum point at which to intervene to prevent decline. As part of this work, we also looked at different measures of strength, to identify an appropriate measure that could be administered in any large scale surveys, epidemiological studies or interventions.

This work aimed to:

1. Provide an overview of the existing evidence on the patterns and trends of the UK population levels of strength.
2. Identify whether there are key ages and sub-populations at which intervention would be most fruitfully targeted.
3. Identify methods used in the assessment of strength and, based on criteria to be defined during the scoping phase such as validity, reliability, acceptability and practicality, to make recommendations for methods to be used in future population-based studies.
4. Inform further research requirements.

Our approach

We worked with colleagues in DHSC to formulate five questions and answered these through looking at the existing academic literature.

1. How does strength change across the life course?
2. How can we measure strength across the life course?
3. What is the correlation between hand grip strength and functional tests?
4. Has handgrip strength been measured in different populations?
5. What is known about how strength changes in childhood and adolescence?

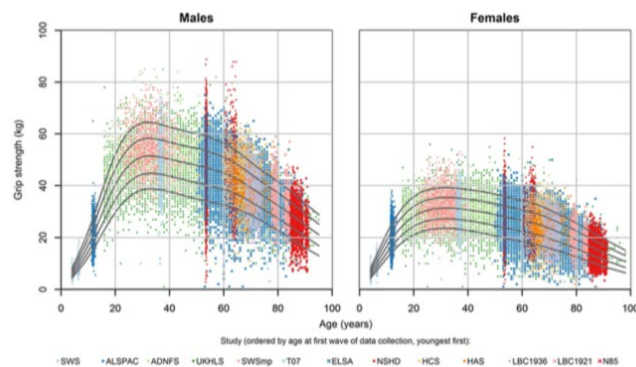
To answer the first question, we conducted a scoping search to identify studies that had measured strength over time, in order to identify patterns of strength across the life course. For the second question, we sought to identify measures of muscle strength in cohort studies and population surveys. To investigate the correlation between handgrip strength and functional tests, which measure lower limb strength, we conducted a further scoping search; re-examined results from the searches of cohort studies, where both tests had been administered; and made contact with colleagues actively researching in the field. To look for measurement of hand grip strength in different populations, we revisited the searches previously conducted to

find systematic reviews or individual studies reporting the validation of hand grip strength measurement in different populations (e.g. older adults, adults, children and learning disability). Similarly, to look specifically at how strength changes during childhood and adolescence, we revisited our original searches. These had been set up to examine all studies including children in full text.

Overview of findings and implications for policy

1. How does strength change across the life course?

We identified five studies that examined changes in strength across the life course. Four of these used hand grip strength as the measure of muscle strength and found that strength peaks in early adulthood, is maintained until mid-life, and then declines with age. Males are stronger than females from adolescence onwards, with peak median grip at 51kgs (29-39 years) compared to 31kgs for females (26-42 years). Knee strength was used as a measure in one study, demonstrating a similar decline in strength from middle age. A key point at which to intervene to maintain muscle strength would therefore be between a person's late 20s and early 40s. The graphs below from the analysis by Dodds et al., 2014, highlight the change in hand grip strength across the life course.



Reproduced from Dodds et al. Grip strength across the life course: normative data from twelve British studies. PLoS One. 2014;9(12):e113637.

2. How can we measure strength across the life course?

We examined 99 cohort studies/panel surveys to search for measures of strength. Studies searched included data from children (5-18), adults (19-64) and older adults (65+). The measures of strength identified are listed below.

- Measures of strength were identified in 64/99 studies.
- The most common measure was **hand grip strength**, which was included in 53/64 studies.

- **Hand grip strength for children** was measured in three studies. Other measures of **strength for children** were **muscle mass by DXA scan, muscle mass by bioelectric impedance analyser, knee muscle strength** and the **Functional Strength Assessment**.
- **Quadriceps strength** was measured in two studies, with adults and older adults.
- The Timed-Up-and-Go test (**TUG**) was used in five studies, with adults and older adults.
- The **five times sit -to-stand** (chair rises) test was used in 17 studies, one with adolescents aged 15 and older, the others with adults and older adults.
- The **10 times sit-to-stand** (chair rises) was used in four studies, with adults and older adults.
- **Muscle mass by DXA scan** was measured in four studies, one including children and adults.
- **Skeletal muscle mass** was estimated using a **bioelectric impedance analyser** in two studies, one with children (see above) and the other with adults only.
- **Lower leg extension power**, using a power rig, was measured in two studies of adults.
- **Knee muscle strength** was measured in two studies, one including children and adults, and the other with adults and older adults.
- **Maximal muscle force** was measured by a two-legged counter-movement jump on a force plate in one study. This study included adults only.

Hand grip strength is the most commonly used measure of strength in population surveillance surveys, cohort studies and research studies. As a measure, it has strong validity and test-retest, inter-rater and intra-rater reliability, provided protocols for administering the test are followed. The Timed Up and Go test and Sit-to-Stand tests have also been found to be reliable and valid test in populations of older people and younger people with long term conditions. The instrumented Sit-to-Stand test, using body-fixed inertial sensors, has demonstrated strong test-retest, and absolute, reliability. The instrumented Timed Up and Go (iTUG) has demonstrated excellent test-retest reliability and inter-rater reliability. iTUG has been shown to be an objective, fast, reliable and sensitive test of mobility in older populations.

3. What is the correlation between hand grip strength and functional tests?

Many studies have demonstrated high correlation between hand grip strength and lower limb strength in older adults. Strong correlations between grip strength and total muscle strength (measured in the shoulder abductor, hip and ankle flexors)

have been found in children and young adults aged 8-20 years. There is a very small literature on correlations between hand grip strength and functional tests. Only 10 papers were identified through our searches. There is some evidence of correlations between hand grip strength and functional tests, but there are few papers reporting meaningful correlations, after adjustment for confounders. However, it remains true that there is strong evidence that hand grip strength is an indicator of total body muscle strength, and that it is a strong predictor of mobility impairment, disability and mortality.

4. Has handgrip strength been measured in different populations?

Hand grip strength has been shown to have high test-retest reliability in pre-school children, children and pre-adolescents, adults with learning disabilities, older adults, healthy adults, and various clinical populations. Hand grip strength appears to be a reliable measure of muscle strength in all phases of the life course. However, it is important to follow established protocols to overcome issues of variability.

5. What is known about how strength changes in childhood and adolescence?

Only one of the papers identified in the initial scoping exercise included reports of changes in strength within the 5-18 age band. This paper, reporting grip strength across the life course by Dodds et al., included data from children aged four years and over. The results show that mean values for grip strength are similar for boys and girls at age 10. Hereafter, males' hand grip strength increases faster than females'; both peak in early adulthood.

Conclusion

The evidence supporting hand grip strength as a powerful predictor of decline in intrinsic capacity, morbidity and mortality, together with its ease of use and clear protocol, lends itself to support hand grip strength as a strong candidate for measuring strength across the life-course. If functional tests, such as Sit-to Stand or Timed-Up-and-Go, are to be added to population studies they must include clear standardised protocols. Starting to intervene in the third and fourth decades of life is likely to achieve optimal outcomes, providing the opportunity for adults to maintain their levels of muscle strength from their peak.



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