Wearable systems for monitoring mobility-related activities in older people: a systematic review

de Bruin ED, Hartmann A, Uebelhart D, Murer K, Zijlstra W

CRD summary
The authors concluded that wearable devices for monitoring physical activity in people over 65 were available and feasible, but that they required further development. Although poor reporting makes it impossible to gauge the reliability of the clinical findings of the review, the authors’ overall conclusion, that more evidence is needed, appears justified.

Authors’ objectives
To identify the feasibility, adherence and clinical relevance of wearable motion-sensing technology for monitoring mobility-related activities in older people and to describe the types of device used.

Searching
The following databases were searched up to January 2007: MEDLINE (from 1990), BIOSIS Previews, CINAHL and Cochrane Central Register of Controlled Trials (CENTRAL). Search terms were reported. Reference lists of relevant articles were checked. The search was limited to papers in English, French, German or Dutch.

Study selection
Studies of wearable motion-sensing devices for long-term monitoring of mobility were eligible for inclusion, provided they were conducted in free-living populations, with a mean age of at least 65 years. Case studies were included if at least one of the participants was aged at least 65 years. Outcomes were required to include one of the following International Classification of Functioning, Disability and Health categories: ‘changing and maintaining body position’, or ‘walking and moving’.

Participants in the review were men and women with a mean or median age of 68 to 80 years, where stated. Some studies included participants with medical problems (e.g. pulmonary disease, arterial disease, hip fracture, diabetes, osteoarthritis). Motion-sensing devices in the review included pedometers (step counters to evaluate walking), uniaxial accelerometers (for measuring activity over a defined time), multi-axial movement sensors (for long term monitoring of activity) and combinations of uniaxial devices (for posture detection). In clinical studies, physical activity monitors were commonly used in conjunction with interventions such as an exercise or rehabilitation programme and/or hospital admission or surgery for treatment of medical problems. Outcomes reported in the review were the types of device used, their feasibility and acceptance, and their clinical relevance.

Two reviewers independently selected the studies, with disagreements resolved by consensus or by a third reviewer.

Assessment of study quality
Study validity was assessed by adapting a published checklist to score 18 items covering the following domains: quality of reporting, external validity, internal validity (risk of bias and/or confounding), and power. The maximum score was 22 points. A copy of the checklist was provided.

Two reviewers independently assessed study validity.

Data extraction
The authors did not state how the data were extracted for the review, or how many reviewers performed the data extraction.

Methods of synthesis
Studies were combined by narrative synthesis.
Results of the review
Forty-two studies were included in the review; eight studies were experimental (i.e. randomised controlled trial (RCT), comparative clinical trial or single-subject design); 23 studies were exploratory (e.g. case-control, cohort or correlational design); eight studies were descriptive (e.g. case study); and three studies had a mixed exploratory/descriptive design. The median quality score was 11 points (range 4 to 21 points). There were only three RCTs, with a quality score of over 20.

Feasibility and adherence (seven studies): Relevant findings related mainly to the reliability of devices in unsupervised settings and their acceptability by study participants and/or assessors. Some devices were attached in such a way (e.g. to hip or shoes) that measurement was impeded and acceptability was low.

Clinical relevance (eight studies, n=353 participants): Physical activity increased in participants in whom accelerometers (two studies) or pedometers (one study) showed gains in physical performance. Self-report measures showed no change in two of these studies, and there was no equivalent benefit associated with their use. There was some evidence of improved clinical outcomes among patients with diabetic ulcers (one study, n=1 participant), chronic obstructive pulmonary disease (two studies, n=197 participants) and osteoarthritis (one study, n=17 participants) associated with the use of activity monitoring in conjunction with interventions to increase exercise and improve rehabilitation. One study suggested that pedometers appeared useful as a motivational tool to enhance exercise levels.

Authors’ conclusions
The authors concluded that wearable devices for monitoring physical activity in people aged over 65 years were available and feasible, but that they required further development.

CRD commentary
The objectives and inclusion criteria of the review were clear and relevant sources were searched for studies. A language restriction was applied but this did not result in the exclusion of any studies. It was unclear whether the search was restricted by publication status.
Steps were taken to minimise the risk of reviewer bias or error by having more than one reviewer independently select studies and conduct quality assessment, but the process used for data extraction was not described.

The use of narrative synthesis to combine the studies was appropriate, given their heterogeneity. With respect to the studies with clinical outcomes, insufficient information was provided about the design of individual studies and minimal quantitative information was cited to support their results. No measures of statistical significance were reported. These factors made it impossible to gauge the clinical significance of their findings. Also, there was no indication of the design or sample size of the non-clinical studies. The authors acknowledged the lack of good quality RCTs but did not explicitly prioritise the results of RCTs in the interpretation of findings.

Although poor reporting makes it impossible to gauge the reliability of the clinical findings of the review, the authors’ overall conclusion, that more evidence is needed, appears justified.

Implications of the review for practice and research
Practice: The authors stated that a clinician selecting a wearable motion-sensing device should consider its psychometric properties and feasibility among the intended population and should set clear measurement goals in a clinical setting. They suggested that miniaturised sensors and/or sensors integrated into clothing were preferable.

Research: The authors stated that research is required on wearable motion-sensing systems to assess balance and to prevent or predict falls. Accelerometry appears promising for ambulatory monitoring in the elderly, but pedometers do not appear reliable as a measure of physical activity. Studies should evaluate older peoples’ satisfaction with the device and should be conducted in a real-life setting.

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