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The Impact of Wearable Motion Sensing Technologies on Physical Activity: A Systematic Review

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PREFACE

The VA Evidence-based Synthesis Program (ESP) was established in 2007 to provide timely and accurate syntheses of targeted healthcare topics of particular importance to clinicians, managers, and policymakers as they work to improve the health and healthcare of Veterans. QUERI provides funding for four ESP Centers, and each Center has an active University affiliation. Center Directors are recognized leaders in the field of evidence synthesis with close ties to the AHRQ Evidence-based Practice Centers. The ESP is governed by a Steering Committee comprised of participants from VHA Policy, Program, and Operations Offices, VISN leadership, field-based investigators, and others as designated appropriate by QUERI/HSR&D.

The ESP Centers generate evidence syntheses on important clinical practice topics. These reports help:

- Develop clinical policies informed by evidence;
- Implement effective services to improve patient outcomes and to support VA clinical practice guidelines and performance measures; and
- Set the direction for future research to address gaps in clinical knowledge.

The ESP disseminates these reports throughout VA and in the published literature; some evidence syntheses have informed the clinical guidelines of large professional organizations.

The ESP Coordinating Center (ESP CC), located in Portland, Oregon, was created in 2009 to expand the capacity of QUERI/HSR&D and is charged with oversight of national ESP program operations, program development and evaluation, and dissemination efforts. The ESP CC establishes standard operating procedures for the production of evidence synthesis reports; facilitates a national topic nomination, prioritization, and selection process; manages the research portfolio of each Center; facilitates editorial review processes; ensures methodological consistency and quality of products; produces “rapid response evidence briefs” at the request of VHA senior leadership; collaborates with HSR&D Center for Information Dissemination and Education Resources (CIDER) to develop a national dissemination strategy for all ESP products; and interfaces with stakeholders to effectively engage the program.

Comments on this evidence report are welcome and can be sent to Nicole Floyd, ESP CC Program Manager, at Nicole.Floyd@va.gov.

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STRUCTURED ABSTRACT

Background: Participation in regular physical activity is important for improving health, but sedentary behavior is difficult to change. One option is to provide feedback on physical activity with wearable motion sensing technologies (activity devices). This review sets out to synthesize the literature on the effectiveness of these devices for physical activity, weight, and patient satisfaction outcomes, and to describe moderating factors that may impact effectiveness (*ie*, population characteristics, location where device is worn on body, or device role in overall intervention approach).

Methods: We searched MEDLINE, Embase, CINAHL, SPORTDiscus, and Cochrane CENTRAL from January 1, 2000, to January 6, 2015, for peer-reviewed, English-language randomized controlled trials among adults (≥18 years of age). Article inclusion, data abstraction, and quality assessment were conducted through a duplicate process, with discussion to resolve discrepancies. Trial quality was evaluated as low, unclear, or high risk of bias (ROB). Strength of evidence (SOE) was summarized as high, moderate, or low. Random-effects models were used to produce standardized mean differences (SMDs) for physical activity outcomes and mean differences (MDs) for weight outcomes. Heterogeneity was measured with I^2. Qualitative synthesis was conducted for outcomes with <3 studies.

Results: We identified 4787 unique citations; 14 trials met eligibility criteria. Women comprised 62.5% of the population. Median age was 49.7 years (range 28.7 to 79.8 years). Study sizes ranged from 20 to 544 participants (median 62), with the majority of studies (n=8) randomizing <70 participants. Although all of the interventions had multiple components, in the majority of studies (n=8), the wearable device was used in a major role (*ie*, central motivational enhancement). The device was an accelerometer in all 14 studies.

Twelve trials (2 at low ROB, 2 at unclear ROB, 8 at high ROB) examined accelerometer interventions for increasing physical activity; the majority (n=9) used an inactive comparator. Overall, a small significant effect was found for increasing physical activity (SMD 0.26; 95% CI 0.04 to 0.49) with high heterogeneity (I^2=64.7%). Moderate SOE was found for small increases in physical activity when compared with an inactive comparator (SMD 0.29; 95% CI 0.03 to 0.55) with high heterogeneity (I^2=70.3%). Low SOE and no statistically significant effect (SMD 0.17; 95% CI -1.09 to 1.43) were found when compared with an active comparator.

Eleven trials (2 at low ROB, 3 at unclear ROB, 6 at high ROB) examined the effect of accelerometer interventions on weight loss or maintenance. The overall pooled estimate showed a small significant effect for weight loss (MD -1.65 kg; 95% CI -3.03 to -0.28) with high heterogeneity (I^2=81%). Moderate SOE and no significant effect were found for accelerometers versus inactive comparators (MD -1.44 kg; 95% CI -3.08 to 0.19). A positive trend with low SOE for accelerometers was found in 2 trials on weight loss, but only one was statistically significant.

No studies reported the outcome of patient satisfaction with healthcare. Also, no moderating factors were found to significantly impact effectiveness or explain heterogeneity.

Conclusions: The small positive effects produced by interventions that include accelerometers may not result in a clinically significant impact on physical activity or weight loss; however, the small sample sizes with moderate to high heterogeneity in the current studies limit the conclusions that may be drawn. Larger, well-designed randomized controlled trials are needed. Clinicians and policymakers should consider these findings and the existing gaps in the literature before widespread use of these technologies.

ABBREVIATIONS TABLE

AHRQ	Agency for Healthcare Research and Quality
CCRBT	Cochrane Collaboration Risk of Bias Tool
CI	Confidence interval
COPD	Chronic obstructive pulmonary disease
ESP	Evidence-based Synthesis Program
GPS	Global positioning system
HSR&D	Health Services Research & Development
KQ	Key question
MD	Mean difference
MeSH	Medical Subject Heading
NCP	National Center for Health Promotion and Disease Prevention
PA	Physical activity
PICOTS	Population, intervention, comparator, outcome, timing, and setting
QUERI	Quality Enhancement Research Initiative
RCT	Randomized controlled trial
ROB	Risk of bias
SEM	Standard error of the mean
SMD	Standardized mean difference
SOE	Strength of evidence
VA	Veterans Affairs
VHA	Veterans Health Administration
VISN	Veterans Integrated Service Networks