Preventive Medicine Reports 8 (2017) 183–189

Contents lists available at ScienceDirect

Preventive Medicine Reports

journal homepage: www.elsevier.com/locate/pmedr

Associations of lifetime walking and weight bearing exercise with accelerometer-measured high impact physical activity in later life

Ahmed Elhakeem[a,*], Kimberly Hannam[a], Kevin C. Deere[a], April Hartley[a], Emma M. Clark[a], Charlotte Moss[b], Mark H. Edwards[b], Elaine Dennison[b], Tim Gaysin[c], Diana Kuh[c], Andrew Wong[c], Kenneth R. Fox[d], Cyrus Cooper[b], Rachel Cooper[c], Jon H. Tobias[a]

[a] Musculoskeletal Research Unit, Translational Health Sciences, Bristol Medical School, University of Bristol, UK
[b] MRC Lifecourse Epidemiology Unit, University of Southampton, UK
[c] MRC Unit for Lifelong Health and Ageing at UCL, UK
[d] Centre for Exercise Nutrition and Health Sciences, University of Bristol, UK

ARTICLE INFO

Keywords:
Accelerometer
Exercise
Life course
Physical activity

ABSTRACT

High impact physical activity (PA) is thought to benefit bone. We examined associations of lifetime walking and weight bearing exercise with accelerometer-measured high impact and overall PA in later life. Data were from 848 participants (66.2% female, mean age = 72.4 years) from the Cohort for Skeletal Health in Bristol and Avon, Hertfordshire Cohort Study and MRC National Survey of Health and Development. Acceleration peaks from seven-day hip-worn accelerometer recordings were used to derive counts of high impact and overall PA. Walking and weight bearing exercise up to age 18, between 18–29, 30–49 and since age 50 were recalled using questionnaires. Responses in each age category were dichotomised and cumulative scores derived. Linear regression was used for analysis. Greater lifetime walking was related to higher overall, but not high impact PA, whereas greater lifetime weight bearing exercise was related to higher overall and high impact PA. For example, fully-adjusted differences in log-overall and log-high impact PA respectively for highest versus lowest lifetime scores were: walking [0.224 (0.087, 0.362) and 0.239 (−0.058, 0.536)], and weight bearing exercise [0.754 (0.432, 1.076) and 0.587 (0.270, 0.904)]. For both walking and weight bearing exercise, associations were strongest in the 'since age 50' category. Those reporting the most walking and weight bearing exercise since age 50 had highest overall and high impact PA, e.g. fully-adjusted difference in log-high impact PA versus least walking and weight bearing exercise = 0.588 (0.226, 0.951). Promoting walking and weight bearing exercise from midlife may help increase potentially osteogenic PA levels in later life.

1. Introduction

The many health benefits of physical activity (PA) include reduced risk of chronic diseases (Lee et al., 2012), increases in bone mineral density (Marques et al., 2012), prevention of falls and fractures (Gardner et al., 2000; Qu et al., 2014) and maintenance of physical capability (Cooper et al., 2011) and independent living during older age (McPhee et al., 2016). It is thought that benefits of PA for bone are mediated by deformations caused by higher impacts or loading forces, leading to new bone which subsequently reduces risk of osteoporosis (Hannam et al., 2016a; Martyn-St James and Carroll, 2009; Tobias et al., 2014). For example, we recently developed (Deere et al., 2016) an accelerometer-based method for characterising PA according to vertical impact, and showed that positive associations between PA and lower limb bone strength in postmenopausal women were explained by exposure to vertical impacts ≥ 1.5 g, despite their rarity (Hannam et al., 2016a). To develop interventions that are more effective at promoting higher impact PA in later life (and subsequent accrual of associated benefits for bone), a better understanding of the determinants of higher impact PA is required.

Prior history of PA has been identified as an important correlate of current PA (Bauman et al., 2012) and it is thought that PA is relatively stable across life though tracking becomes weaker as time between measures increases (Hirvensalo and Lintunen, 2011; Telama, 2009). For example, in the Medical Research Council (MRC) National Survey of Health and Development (NSHD), greater leisure-time PA at ages 36, 43 and 53 were related to higher moderate-to-vigorous PA (MVPA) assessed by activity monitors at age 60–64 (Golubic et al., 2014).

* Corresponding author at: Musculoskeletal Research Unit, Translational Health Sciences, Bristol Medical School, University of Bristol, Learning & Research Building Level 1, Southmead Hospital, BS10 5NB Bristol, UK.
E-mail address: a.elhakeem@bristol.ac.uk (A. Elhakeem).

http://dx.doi.org/10.1016/j.pmedr.2017.10.011
Received 26 July 2017; Received in revised form 6 October 2017; Accepted 16 October 2017
Available online 25 October 2017

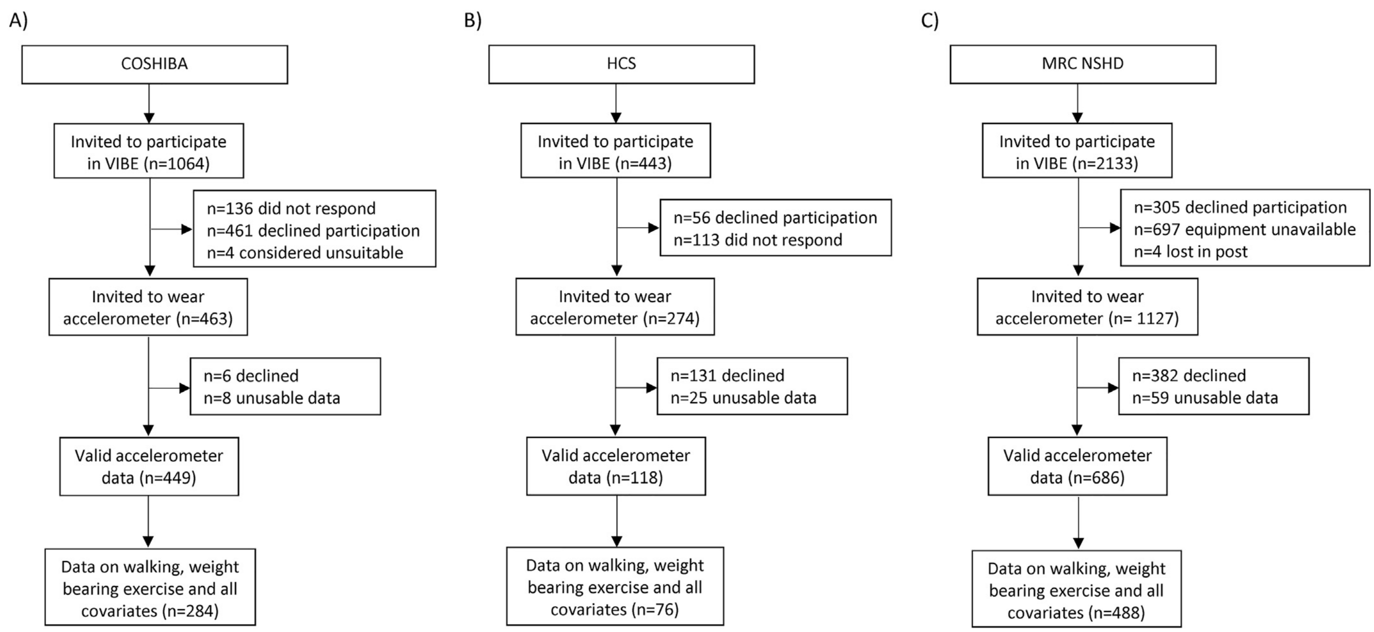

Fig. 1. Study flowchart. Recruitment of VIBE study participants from A) COSHIBA, B) HCS and C) MRC NSHD. COSHIBA: Cohort for Skeletal Health in Bristol and Avon. HCS: Hertfordshire Cohort Study. MRC NSHD: Medical Research Council National Survey of Health and Development.

Similarly, in the Whitehall II study, self-reported PA frequency in midlife was associated with accelerometer-measured MVPA 13 years later (Hamer et al., 2012), and higher PA at age 40 recalled by 70–77 year-old Norwegians was related to higher accelerometer counts/minute (Viken et al., 2016).

It is unclear if greater PA across life cumulatively relates to greater volume of PA in later life, or if participation at later ages is more important. Moreover, few studies have objective measures of high impact PA in old age and none have examined the lifetime correlates of PA producing osteogenic vertical impacts at older age, including how different types of PA relate to higher impacts in later life. For example, walking is generally a lower impact activity that is unrelated to bone (Hannam et al., 2016a) whereas activities like jogging and dancing produce higher impacts, and participation in lower and higher impact PA could track across life. Therefore, in this study, we provide novel insights into determinants of high impact PA which may ultimately aid intervention design by using data from the Vertical Impacts on Bone in the Elderly (VIBE) study (Deere et al., 2016) to examine associations of walking and weight bearing exercise over the life course with accelerometer-measured high impact and overall PA in later life. We also examine the relative contributions of walking and weight bearing exercise to high impact PA at older age. We hypothesised that greater lifetime self-reported weight bearing exercise would be related to higher levels of osteogenic PA in later life and that greater participation in both walking and weight bearing exercise would translate to higher levels of high impacts.

2. Materials and methods

2.1. Study population

Participants were recruited to the VIBE study from the Cohort for Skeletal Health in Bristol and Avon (COSHIBA), Hertfordshire Cohort Study (HCS) and MRC NSHD. COSHIBA is a representative population-based cohort of 3200 women recruited through fifteen general practices in the Bristol and Avon area during 2007–2009, originally set up to investigate determinants of skeletal health in postmenopausal women (Clark et al., 2012). Only the 1286 COSHIBA participants who consented to be contacted about future research studies in 2014 and remained resident in the Bristol and Avon area were eligible to participate in the VIBE study. HCS comprises 3225 singleton births in Hertfordshire between 1931 and 1939 that still lived in the area during 1998–2003 (Syddall et al., 2005). Only the 443 HCS participants who were previously included in the UK arm of the European Project on Osteoarthritis (EPOSA) (Schaap et al., 2011) were invited to participate in VIBE. NSHD is a nationally representative sample of 5362 singleton births from one week in March 1946 (Kuh et al., 2011; Wadsworth et al., 2006). Most participants (79%) included in the home visit phase of the NSHD 24th data collection (2015–2016) (Kuh et al., 2016) were invited to participate in VIBE. In total, 3640 participants from the three cohorts were eligible to be invited to participate in the VIBE study.

Separate regional ethical approval was obtained for data collection in NSHD (14/LO/1073 and 14/SS/1009), HCS (10/HO311/59) and COSHIBA (14/SW/0138) and written informed consent was obtained from all participants.

2.2. Current PA

Participants who were invited and agreed to accelerometry monitoring, subject to availability of monitors, were provided with a GCDC X15-1c triaxial accelerometer (Gulf Coast Data Concepts, Waveland, Mississippi), custom designed size specific elasticated belt, a time log and a stamped addressed package along with written and, if seen in clinic or during a nurse home visit, verbal instructions. Accelerometers were configured with standardised settings prior to participant use with a sampling frequency of 50 Hz to detect brief high impacts, a deadband setting of 0.1 g (the threshold which must be exceeded before a recording is made) and a timeout setting of 10 s (a single sample every 10 s is forced even if the recording is < 0.1 g), to ensure monitors record continuously for seven days on a single battery charge. Participants were instructed to wear the accelerometer securely positioned over their right hip pointing toward the centre of their body for seven continuous days, removing only for sleeping, washing and swimming. A time log was provided for participants to record when the monitor was put on in the morning and taken off at night for each monitoring day and any reason why that day had not been reflective of their normal activity.

Raw triaxial accelerometry data were uploaded to a secure shared drive and read into Stata 13 (StataCorp, College Station, TX) for standardised cleaning and processing by the coordinating centre, described