British Journal of Nutrition

cambridge.org/bjn

Studying multiple health behaviours in older adults using a measurement burst design: protocol, feasibility, compliance, behavioural patterns and lessons learned

Kim Cnudde[1,2], Laura Maenhout[1,2], Femke De Backere[3], Femke Ongenae[3] and Delfien Van Dyck[1]

[1]Department of Movement and Sports Sciences, Ghent University, Ghent, Belgium; [2]Research Foundation Flanders (FWO), Brussels, Belgium and [3]IDLab, Department of Information Technology, Ghent University – imec, Ghent, Belgium

Research Article

Cite this article: Cnudde K, Maenhout L, De Backere F, Ongenae F, and Van Dyck D (2026). Studying multiple health behaviours in older adults using a measurement burst design: protocol, feasibility, compliance, behavioural patterns and lessons learned. *British Journal of Nutrition*, page 1 of 12. doi: 10.1017/S0007114526108526

Received: 8 April 2026 UTC
Revised: 20 August 2026 UTC
Accepted: 28 August 2026 UTC

Keywords:
diet; physical activity; sedentary behaviour; sleep; determinants; elderly; behaviour change; lifestyle medicine; precision health; public health; intensive longitudinal study

Abbreviations:
PA, physical activity; SB, sedentary behaviour; EMA, ecological momentary assessment; SFA, saturated fatty acids; LPA, light physical activity; MPA, moderate physical activity; VPA, vigorous physical activity; SD, standard deviation; M, mean

Corresponding author:
Kim Cnudde; Email: kim.cnudde@ugent.be

Abstract

Overweight and obesity are major public health challenges, requiring preventive efforts targeting diet, physical activity (PA), sedentary behaviour (SB) and sleep. Current research often treats these behaviours in isolation, ignores daily fluctuations and focuses on between-person differences. Studies examining the temporal covariance of these behaviours, assessing within-day and day-to-day variations in determinants and exploring how these time-varying determinants predict within-person variability in behaviours are needed. This paper aims to evaluate the feasibility of a measurement burst design with repeated intensive longitudinal assessments and to present patterns of behaviours and determinants. A 12-month observational study with a measurement burst design was conducted (January–December 2025). In total, 130 participants aged 55–75 years enrolled in the study, which consisted of four 7-day measurement bursts. Data collection included monitoring of diet, PA, SB, sleep and time-based ecological momentary assessment (EMA). Compliance rates, descriptive statistics per burst and across bursts were computed. 116 participants completed all bursts (retention rate = 89·2 %). Compliance rates ranged from 83·5 % for time-based EMA to 91·8 % for SB, supporting feasibility of the protocol. Mean values of 1692 kcal/day (SD = 565) for energy intake, 9·4 h/day (SD = 2·4) for sedentary time and 10 610 steps/day (SD = 6302) were observed. Mean daily light, moderate and vigorous PA-levels were 102·9 (SD = 37·4), 65·5 (SD = 43·4) and 11·5 (SD = 17·0) minutes, respectively. Mean sleep duration was 6·4 h/night (SD = 1·3), with a mean sleep efficiency of 79·2 % (SD = 10·2). This paper demonstrated the feasibility of integrating multiple assessment methods within a measurement burst design for studying health behaviours in adults aged 55–75 years and highlighted the value of analyses at more fine-grained temporal and individual levels.

Introduction

The WHO clearly states that overweight and obesity are among the greatest public health challenges of the century[1]. The direct cost of treating obesity-induced diseases in European adults is estimated at approximately 7 % of health budgets, putting pressure on healthcare[2]. While disrupted energy balance is a primary cause[3], genetic predisposition, hormonal factors and medication also play significant roles[4]. However, from a health interventionist perspective, targeting energy balance, determined by dietary intake, physical activity (PA), sedentary behaviour (SB) and sleep, is promising as these behaviours can be affected by behaviour change interventions.

While existing research has been innovative and valuable, tackling three shortcomings is essential to advance the field. First, diet, PA, SB and sleep are often studied in isolation, although the multiple health behaviour approach emphasises their strong interconnection[5,6]. As Heino et al.[6] underscore, such interrelated behaviours are core elements of complex systems: dynamic, intertwined processes are co-dependent and cannot be separated without losing essential information on how the system as a whole operates. Therefore, a more holistic approach is needed, and dietary intake, PA, SB and sleep should be examined simultaneously.

Second, day-to-day and within-day variations in behaviours and determinants are often neglected. Behaviours as well as determinants tend to vary daily and within days due to interactions between individuals and their changing interpersonal and environmental contexts[6–8]. These time-dependent variations (e.g. changes in environment, emotions) imply that maintaining a healthy lifestyle can be challenging over time. So, understanding the micro-temporal processes underlying these behaviours is crucial to promote a healthy lifestyle[7]. Despite this, behaviours are often measured at a single timepoint,[8,9] and determinants are usually assessed only once, or repeatedly over longer periods. Instead, these factors should be considered as complex, potentially non-linear and dynamic[6]. Therefore, a shift from low- to

© The Author(s), 2026. Published by Cambridge University Press on behalf of The Nutrition Society.

https://doi.org/10.1017/S0007114526108526 Published online by Cambridge University Press

high-resolution assessments of behaviours and determinants is necessary, requiring multiple repeated and detailed measurements.

Third, many studies focus on associations across persons. However, not everyone follows the same behaviour processes, a concept known as 'non-ergodicity', another key feature of complex systems. This implies that individual processes cannot be inferred from group-level data[6]. The lack of group-to-individual generalisability threatens the validity of results. Despite this, mainly group-level between-person associations between determinants and behaviours are currently being examined. Thus, disentanglement of within-individual processes is crucial by starting from the individual level instead of the group level.

To better understand these interconnected behaviours and their determinants, the 'Leefwijzer 55+' project was initiated to address these shortcomings, and the present paper should be considered as the feasibility and descriptive component of this larger project. The project uses a measurement burst design with repeated intensive longitudinal assessments across multiple timeframes[10,11]. However, the feasibility and participant compliance of such a demanding design remains a critical concern in older adult populations, as low or selective compliance may result in incomplete or biased data[12]. This can limit insight into how multiple health behaviours and their determinants unfold in adults aged 55–75 years, when examined through a holistic lens[13]. To our knowledge, no observational study has previously used a measurement burst design to simultaneously assess dietary intake, PA, SB, sleep and their determinants in this age group over a 12-month period. Consequently, limited evidence is available on the practical feasibility of implementing such a protocol, the level of participant compliance that can be achieved and the challenges that may arise during data collection. Therefore, as an initial step, the first aim of this paper is to evaluate the feasibility of the study protocol by (1) describing the study design and methodology, (2) assessing participant compliance and dropout and (3) reflecting on challenges encountered and lessons learned. The second aim is to present group-level patterns of behaviours and determinants across the measurement bursts, complemented by their day-level patterns.

Methods

This paper followed the STROBE guidelines for observational studies (see Supplementary file 1).

Participants and recruitment

Between November 2024 and January 2025, 130 healthy, community-dwelling, Dutch-speaking adults aged 55–75 years were recruited through convenience sampling in Flanders, Belgium. The study targeted adults aged 55–75 years due to high prevalence of overweight and obesity in this age group[14].

Exclusion criteria were: (1) not being able to walk 100 metres, (2) not living independently at home, (3) cognitive impairment (score on the MoCa test of <24/30) and (4) individuals identified as physically frail. This study was conducted according to the guidelines laid down in the Declaration of Helsinki, and all procedures involving human subjects were approved by the Ethical Committee of Ghent University Hospital (registration number B6702024000361). Written informed consent was obtained from all subjects.

Study design

A 12-month observational study with a measurement burst design was conducted between January and December 2025 (see Figure 1). Participants received four bursts of seven consecutive days, separated by intervals of approximately 12 weeks without measurements. Data were collected at two levels: (1) at baseline: socio-demographics, health status and anthropometrics and (2) during bursts: dietary diary (on 4 of 7 days); continuous monitoring of PA, SB, sleep and time-based ecological momentary assessment (EMA) (6 times/day).

At baseline, participants completed the Tilburg Frailty Indicator[15], the MoCa test, a baseline questionnaire and anthropometric measurements during the first appointment. All appointments were conducted in person, either during a home visit or on campus, depending on participants' preferences. Participants then received face-to-face instructions for the measurement period, supported by a user manual and training session for using the smartphone applications and accelerometers. The applications were installed on participants' smartphones[16,17], and a Motorola G20 was provided to those without one. Participants were guided through a hands-on demonstration of each smartphone application. Each 7-day burst started after the first appointment, and all measurement instruments were collected during a second in-person appointment. During each burst, participants could contact the research team by telephone or e-mail in case of questions or technical difficulties. If needed, additional oral instructions were given by telephone or a supplementary in-person meeting was arranged. Compliance with the time-based EMA protocol was monitored through the SEMA platform, and participants were contacted by telephone or e-mail when their response rate was approximately below 33 %, to verify whether they were receiving the EMA prompts as intended. Between bursts, participants were not required to complete study-related activities. At the start of bursts 2, 3 and 4, participants were contacted personally by telephone to confirm their willingness to continue participation and to schedule the next measurement period. For bursts 2, 3 and 4, a condensed version of the protocol was implemented, during which participants received a brief refresher on the use of both smartphone applications and were provided with the accelerometers, without repeating the full training and application installation procedure conducted at baseline. The same variables were measured across all bursts.

Measurements

Baseline

Socio-demographic variables included age, gender, educational level, marital status, living situation, main occupation, living environment and smoking status. Self-perceived health status was measured using the Dutch EQ-5D-5L questionnaire[18], and medication use was assessed. Body weight was measured using a validated scale (Tanita). Height was self-reported. Waist and hip circumference were assessed using a standard anthropometric tape.

Dietary intake

Participants reported all food and beverage intake on 4 of 7 days (i.e., day 1, 3, 5 and 7) using Traqq, a dietary assessment app developed by Wageningen University[19], and adapted to the Flemish population. Upon opening the app, a searchable food list, based on the Belgian Food Composition Database[20], was

https://doi.org/10.1017/S0007114526108526 Published online by Cambridge University Press

https://doi.org/10.1017/S0007114526108526 Published online by Cambridge University Press

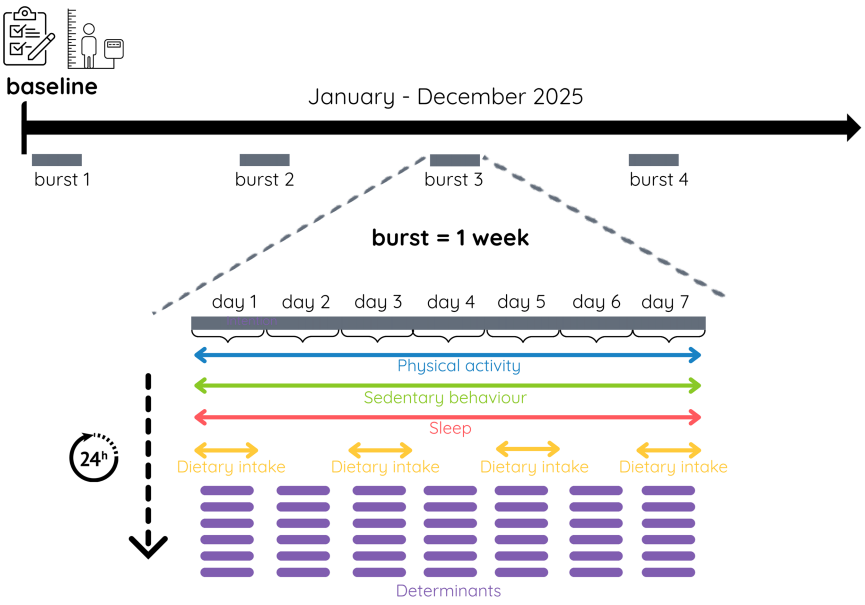


Figure 1. Intensive longitudinal study with measurement burst design.

available. For each item, participants were asked to report quantity (i.e., in household measures, standard portion sizes or grams), timepoint and eating occasion.

Physical activity and sleep

PA and sleep were objectively measured with the GENEActiv (GENEActiv Original), a triaxial and validated research-based accelerometer[21]. The device was continuously worn on the non-dominant wrist for 7 days and 8 nights, 24 hours per day.

Sedentary behaviour

An ActivPAL4 accelerometer (PAL Technologies) was attached on the midline of participants' right anterior thigh with a waterproof sticker, enabling continuous wear for 24 hours per day over 7 days. The ActivPAL is widely regarded as the gold standard for objectively measuring SB[22].

Time-based ecological momentary assessment

Determinants were assessed through time-based EMA, a method involving repeated sampling of experiences in people's everyday lives and enabling the assessment of determinants in real-life situations at multiple moments throughout the day[12].To minimise participant burden, six EMA assessments per day were used[23–25]. Data were collected with SEMA^3 (version 1.4.5), a software tool accompanied by a mobile application designed for time-based EMA studies[16]. SEMA^3 randomly selects a triggering time within six predetermined 1-hour blocks (8·15–9·15; 10·45–11·45; 13·15–14·15; 15·45–16·45; 18·15–19·15, 20·45–21·45), which were chosen based on previous research[23–25]. If participants did not respond, up to two reminders were send, and the questionnaire became inaccessible after 30 min.

The selected determinants align with the COM-B framework (see Figure 2)[26], a comprehensive theoretical framework with four constructs for understanding and promoting health behaviours. Previous EMA research has shown that these determinants are time-dependent in older adults, with momentary assessments linked to subsequent PA[23,24,27] and snacking patterns[25]. All questions used were based on these EMA studies.

Stress, fatigue and pain. Stress and fatigue were captured on a seven-point Likert scale with the question 'How stressed/fatigued were you just before you received the trigger?'. Answers ranged from 1 (strongly disagree) to 7 (strongly agree). Pain was assessed with a Visual Analog Scale (0–100), with the question 'How much pain do you have right now?'.

Physical and social context. To assess the physical context, participants indicated whether they were indoors or outdoors. Those who were indoors specified their location from: home, work, home of relatives or friends, shop, catering facility, public space, sports hall, on the go or other. For those who were outdoors, answer categories included natural environment, built environment, private environment or other.

Social context was assessed by asking 'Are you alone at the moment?'. If not, participants selected from: partner, relative(s), friend(s), colleague(s), caregiver(s), neighbour(s), acquaintance(s), someone I don't know or others.

Emotions, intention and self-efficacy. Positive emotions (relaxation, satisfaction and cheerfulness) and negative emotions (anxiousness, feeling down and loneliness) were captured on a seven-point Likert scale. Mean scores were calculated separately for positive and negative emotions. An example is 'How relaxed were you just before you received the trigger?' with answers ranging from 1 (not at all relaxed) to seven (completely relaxed).

Intention and self-efficacy were assessed separately for PA, SB and diet. To reduce participant burden, each EMA-trigger randomly presented only one question about intention and one about self-efficacy. These were assessed respectively by the items 'In the next hour, I intend/feel able to eat healthy/ limit my sitting/ be active for at least 10 min'. Answers ranged from 1 (strongly disagree) to 7 (strongly agree).

Data processing and statistical analyses

Dietary intake

Data were processed using the Compl-eat computation module[28], which calculates total energy, macro- and micronutrients and

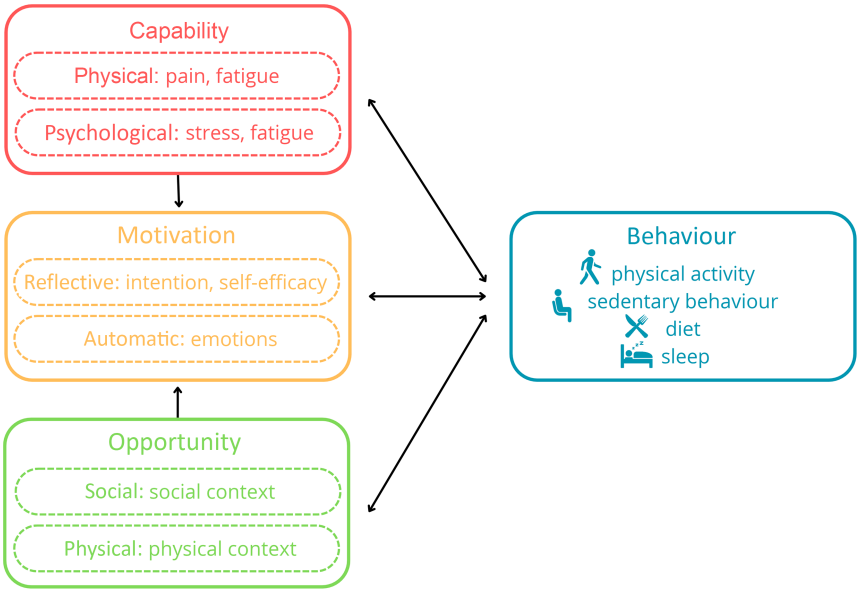


Figure 2. COM-B model adapted from Michie et al. (2011)[26].

food group intakes based on the Belgian Food Composition Database[20]. Two trained dieticians reviewed the data following a standardised protocol and corrected implausible entries using standard portion sizes and recipes[29]. Because self-reported dietary intake is prone to misreporting, which can bias intake estimates[30], days with under- and over-reporting were identified and excluded using the Willet cut-offs (i.e., men: <800 or >4200 kcal, women: <500 or >3500 kcal)[31]. The following variables are included: total energy intake (kcal) and macronutrient intakes expressed as energy percentages (en%), including protein, fat, saturated fatty acids (SFA), carbohydrates, mono- and disaccharides and alcohol, as well as fibre intake (gram).

Physical activity and sleep

Raw data were stored as binary files using GENEActiv PC software (https://activinsights.com/) and processed with the R-package GGIR[32]. Acceleration was sampled at 85,70 Hz. Wear and non-wear time were identified by the procedure outlined by Van Hees et al., and a day was considered valid if wear time is >16 hours (default)[32]. Participants reported when they went to bed and woke up in a paper-based diary, which was used in GGIR's sleep-log function to distinguish daytime from nighttime and to define the sleep period. The following sleep variables were derived: sleep duration, sleep latency (i.e., time between going to bed and falling asleep) and sleep efficiency (i.e. percentage of time in bed spent asleep)[32]. Cut points for (older) adults by Dillon et al.[33] were used to categorise individual minutes as light (105·6 mg), moderate (174·2 mg) or vigorous physical activity (≥330 mg). A burst was considered valid when a participant had at least 4 of 7 days of valid wear time[34].

Sedentary behaviour

Data were downloaded and processed using the manufacturer's proprietary software (activPAL 173 Professional v9.1.5.179). A day was classified as invalid if postural variation was minimal (i.e. ≥95 % of wear time spent in a single activity) or if valid wear time was <10 hours[35,36]. The 'Time in bed adjustment' tool of PAL analysis (v9.2.3.119) was used to manually verify the algorithms that exclude sleep from the analysis. Any discrepancies between the self-reported timepoints and algorithm-derived sleep times were adjusted using the self-reported data[36]. The following variables are included: step counts, sedentary time, lying time, standing time and stepping time. A burst was considered valid when a participant had at least 4 of 7 days of valid wear time[34].

Time-based ecological momentary assessment

All partially completed questionnaires were excluded, and participants with a burst-level compliance rate <50 % were not included in the analyses[12].

Statistical analyses

Analyses were performed in Python (version 3.13.5). To evaluate the feasibility of the study design, a flow chart was created to visualise participant dropout, and a detailed overview of compliance rates for each health behaviour and time-based EMA, including the number of valid measurement days, was provided. Compliance rates were calculated according to Vachon et al., as the ratio of completed measurement occasions to the maximum number of measurement occasions[12,37]. In the present study, this maximum was defined separately for each health behaviour and for time-based EMA. For health behaviours, the compliance was calculated relative to the theoretical maximum number of expected valid assessment days or nights, based on the study protocol for all recruited participants (e.g. 2080 days for dietary intake: 130 participants × 4 bursts × 4 days per burst). For time-based EMA, compliance was calculated relative to the number of prompts actually sent by SEMA^3, as these represented the measurement occasions made available to participants, consistent with previous EMA studies[23–25]. To present the patterns of the health behaviours and determinants, group-level descriptive statistics (i.e., mean (M), standard deviation (SD), minimum, maximum) were calculated for each measurement burst and for the full study period, along with adherence to health behaviour recommendations. Histograms were constructed for each

https://doi.org/10.1017/S0007114526108526 Published online by Cambridge University Press

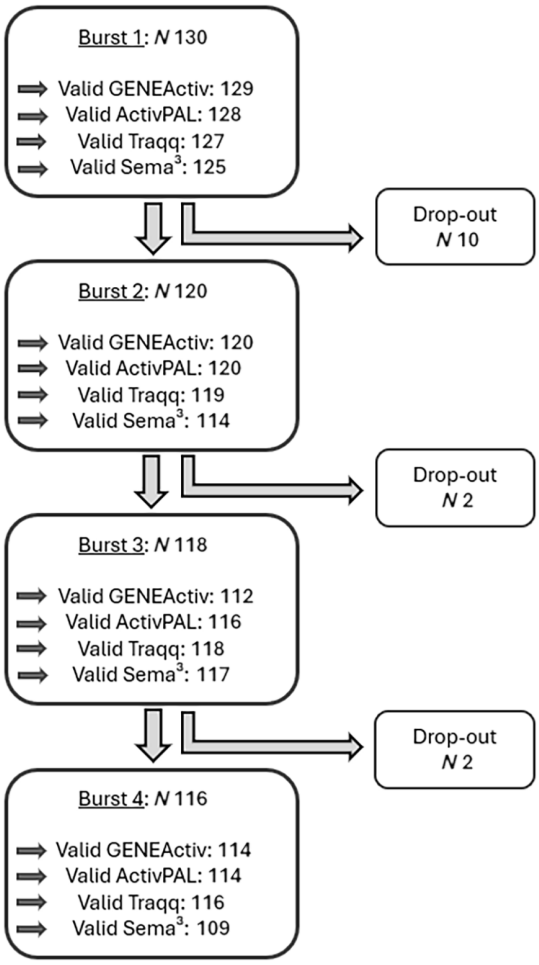


Figure 3. Flow chart of the study sample and valid data per measurement instrument.

behaviour and determinant, including the median, Q1 and Q3. Additionally, an interactive dashboard was developed to visualise day-level patterns.

Results

Feasibility of the study protocol by assessing participant compliance and drop out

Figure 3 presents a flow chart illustrating participant dropout and the number of participants with valid data per measurement instrument. A total of 130 older adults were enrolled, and their socio-demographic characteristics are summarised in Table 1. Ten participants dropped out after the 1st burst due to: limited digital literacy combined with difficulty wearing the GENEActiv during sleep (*n* 1), concerns regarding the accuracy of dietary assessment (*n* 1), feeling stressed about completing time-based EMA questionnaires during work hours (*n* 1), feeling too busy (*n* 2), underestimating study burden (*n* 1) or unspecified reasons (*n* 4). Two additional participants withdrew after the 2nd burst and two more after the 3rd burst, all due to medical or practical circumstances rather than study burden. In total, 116 participants completed all four bursts, corresponding to a retention rate of 89·2 %.

Table 1. Sample characteristics

	Total sample (*N* 130)	
	Mean	SD
Age (years)	65·6	5·9
Sex		
Men (%)	32·3	
Marital status		
Married or living together (%)	75·4	
Single (%)	8·5	
Divorced (%)	12·3	
Widow/widower (%)	3·8	
Education level		
Elementary school (%)	0·8	
Lower secondary (%)	6·2	
Higher secondary (%)	20·0	
Bachelor's degree (%)	50·5	
Master's degree (%)	21·5	
Doctoral degree (%)	0·8	
Living situation		
Living alone (%)	20·8	
Employment status		
Employed (%)	27·7	
Retired (%)	69·2	
Housewife/-husband (%)	0	
Incapacitated (%)	2·3	
Job-seeking (%)	0·8	
Smoking status		
Non-smoker (%)	55·4	
Former smoker (%)	40·8	
Current smoker (%)	3·8	
BMI (kg/m^2)	25·4	4·4
Range	16·6–42·4	
Waist circumference (cm)		
Men	100·1	12·5
Range	74·5–125·0	
Women	88·8	12·6
Range	63·4–120·0	
Hip circumference (cm)		
Men	104·8	6·6
Range	89·5–122·1	
Women	103·6	9·7
Range	85·3–131·3	
Waist-to-hip ratio	0·89	0·08
Range	0·66–1·15	

https://doi.org/10.1017/S0007114526108526 Published online by Cambridge University Press

https://doi.org/10.1017/S0007114526108526 Published online by Cambridge University Press

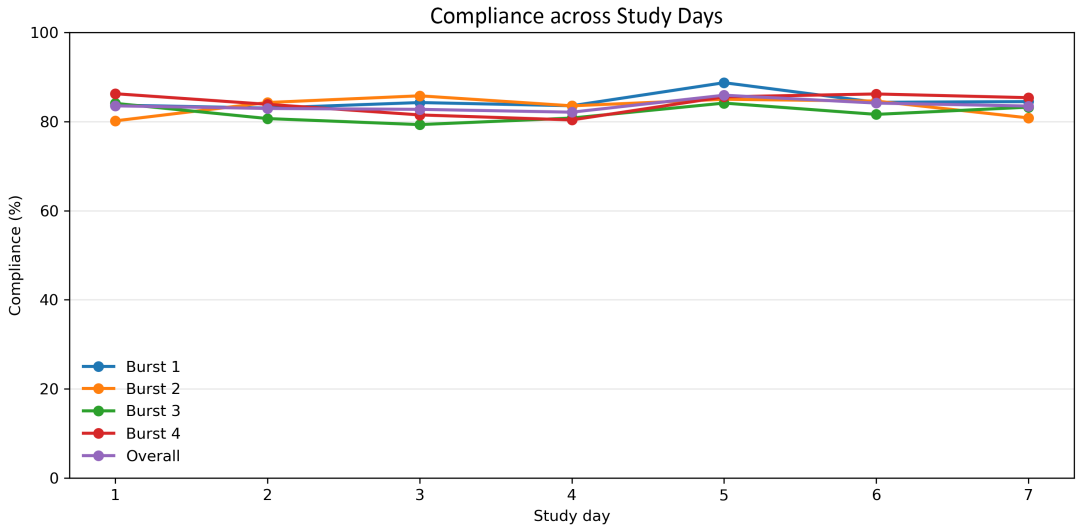


Figure 4. Compliance across study days.

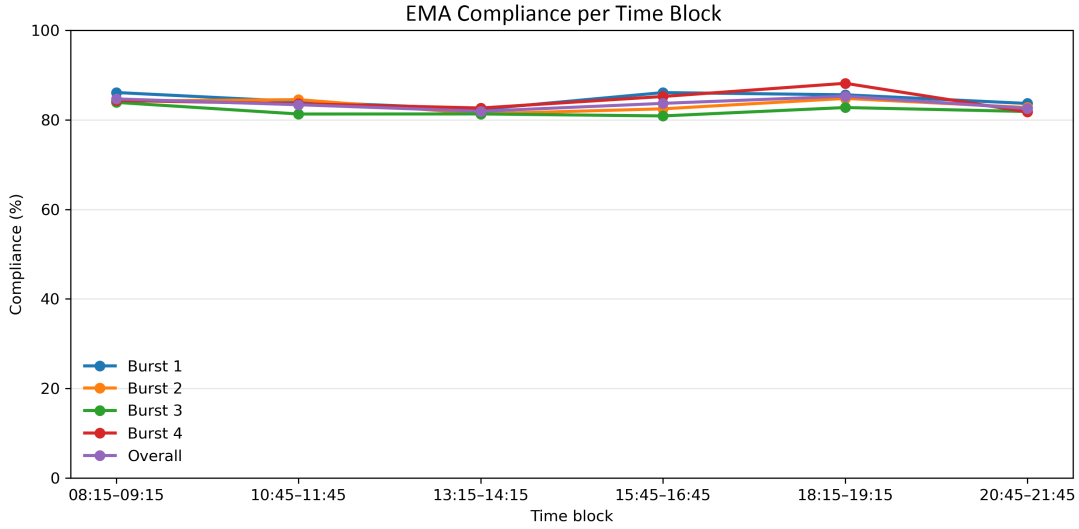


Figure 5. Compliance across time blocks.

Compliance with each measurement instrument across the total study period is calculated. For dietary intake (Traqq), 1895 valid days were recorded out of maximum 2080 possible days, corresponding to a compliance of 91·1 %. 19 358 EMA prompts were sent, of which 16 174 were completed, resulting in an overall response rate of 83·5 %. Compliance with the EMA questionnaires across study days and time blocks is presented in Figures 4 and 5, respectively, and showed limited variation. Furthermore, for PA (GENEActiv), 3314 valid days were obtained out 3640, yielding a compliance rate of 91·0 %, and sleep assessed with the same device resulted in 3725 valid nights out of 4160 (compliance of 89·5 %). SB (ActivPAL) demonstrated with 91·8 % the highest compliance, with 3342 valid days out of 3640. Most data loss from the accelerometers was unintentional and primarily attributable to device loss, technical issues or skin irritation, rather than deliberate non-wear. More detailed burst-level information on dropout and non-compliance is presented in Supplementary file 2.

Patterns of behaviours and determinants

Descriptive statistics for the health behaviours are presented in Table 2. The study sample had a mean daily energy intake of 1692 kcal (SD = 565 kcal), mean sedentary time of 9·4 h (SD = 2·4), an average of 10 610 steps per day (SD = 6302) and mean light, moderate and vigorous physical activity levels of 102·9 min (SD = 37·4), 65·5 min (SD = 43·4) and 11·5 min (SD = 17·0), respectively. Participants showed a mean sleep duration of 6·4 h (SD = 1·3) and mean sleep efficiency of 79·2 % (SD = 10·2 %). Supplementary file 3 provides histograms for all behaviours and determinants, and Table 3 presents the percentage of days meeting the dietary, SB and sleep recommendations, as well as the percentage of participants meeting the PA guideline.

Descriptive statistics for the EMA items are presented in Table 4. Mean levels of negative emotions were 1·7 (SD = 0·8), whereas mean levels of positive emotions were 5·4 (SD = 0·9) on a seven-point scale. Participants reported means levels of pain, stress

Table 2. Descriptive statistics of health behaviours assessed per day

	Burst 1				Burst 2				Burst 3				Burst 4				Total			
	Mean	SD	Min-Max	Days/ nights	Mean	SD	Min-Max	Days/ nights	Mean	SD	Min-Max	Days/ nights	Mean	SD	Min-Max	Days/ nights	Mean	SD	Min-Max	Days/ nights
Dietary intake				503				470				467				455				1895
Energy intake (kcal)	1687	568	625–4034		1737	591	515–3992		1679	550	553–3797		1663	548	537–3305		1692	565	515–4034	
Protein (en%)	16·7	4·7	5·0–40·9		16·1	4·6	6·4–36·5		16·3	4·9	4·8–42·4		16·5	5·0	5·2–42·5		16·4	4·8	4·8–42·5	
Fat (en%)	33·4	9·2	9·7–63·3		35·2	9·0	10·4–62·5		33·9	9·3	9·7–65·9		35·0	8·8	9·6–57·4		34·3	9·1	9·6–65·9	
SFA (en%)	13·2	4·7	3·3–34·6		13·9	5·1	2·4–33·8		13·2	4·9	1·8–33·7		14·2	4·9	2·1–31·1		13·6	4·9	1·8–34·6	
Carbohydrates (en%)	44·4	9·2	8·5–73·0		42·8	8·9	16·0–72·4		43·2	9·5	12·7–75·1		42·5	8·8	15·6–65·9		43·3	9·1	8·5–75·1	
Mono/disaccharides (en%)	19·5	7·5	2·5–57·8		18·4	7·0	2·3–40·3		19·3	7·4	1·9–60·9		18·8	7·2	3·1–41·6		19·0	7·3	1·9–60·9	
Fibre (g)	21·0	8·6	1·7–63·5		19·8	8·1	2·6–57·1		18·8	7·8	1·6–43·6		18·5	7·5	3·2–48·8		19·6	8·1	1·6–63·5	
Alcohol (en%)	2·8	5·1	0–31·7		3·3	5·4	0–30·9		4·1	6·0	0–29·5		3·6	6·2	0–32·4		3·4	5·7	0–32·4	
Physical activity																				
Step count	9986	5938	1096–55 846	896	11 284	6282	1206–45 748	839	10 839	6491	460–47 658	811	10 371	6455	770–41 932	796	10 610	6302	460–55 846	3342
Standing time (h)	4·0	1·6	0·5–12·1	896	4·2	1·6	0·9–11·0	839	4·1	1·7	0·2–10·1	811	4·0	1·7	0·7–10·5	796	4·1	1·6	0·2–12·1	3342
Stepping time (h)	1·8	0·9	0·3–8·1	896	2·0	0·9	0·3–7·6	839	1·9	0·9	0·1–6·7	811	1·9	0·9	0·2–5·6	796	1·9	0·9	0·1–8·1	3342
LPA (min)	99·6	35·4	22·3–253·8	898	106·7	37·3	19·9–275·5	836	106·8	40·6	10·5–257	783	98·8	35·5	17·9–233·4	797	102·9	37·4	10·5–275·5	3314
MPA (min)	64·8	42·3	5·3–412·9	898	67·0	42·2	4·9–313·1	836	64·4	44·3	2·7–288·3	783	65·8	45·0	4·1–268·3	797	65·5	43·4	2·7–412·9	3314
VPA (min)	11·1	14·9	0–109·1	898	12·4	18·4	0–173·4	836	11·7	18·4	0–167·3	783	10·8	16·2	0–141·3	797	11·5	17·0	0–173·4	3314
Sedentary behaviour				896				839				811				796				3342
Sedentary time (h)	9·6	2·4	3·4–16·6		9·3	2·3	2·7–15·4		9·2	2·4	2·0–16·6		9·4	2·3	2·6–15·8		9·4	2·4	2·0–16·6	
Lying time (h)	8·4	1·5	4·0–17·1		8·2	1·4	3·3–14·8		8·4	1·6	2·3–16·9		8·5	1·5	2·9–14·4		8·4	1·5	2·3–17·1	
Sleep				1016				941				869				899				3725
Sleep duration (h)	6·4	1·3	1·3–11·1		6·3	1·3	0·2–11·7		6·2	1·3	0·4–10·1		6·5	1·3	1·3–15·1		6·4	1·3	0·2–15·1	
Sleep latency (h)	0·3	0·4	0–6·5		0·4	0·5	0–5·0		0·3	0·4	0–4·2		0·3	0·4	0–3·5		0·3	0·4	0–6·5	
Sleep efficiency (%)	79·7	9·5	16·3–97·4		78·9	11·1	3·2–98·3		78·6	10·7	6·3–96·8		79·4	9·6	36·5–96·5		79·2	10·2	3·2–98·3	

LPA, light physical activity; MPA, moderate physical activity; VPA, vigorous physical activity.

https://doi.org/10.1017/S0007114526108526 Published online by Cambridge University Press

Table 3. Number and percentage of days or participants meeting the health recommendations*

	Burst 1	Burst 2	Burst 3	Burst 4	Total
Dietary intake					
Protein (en%)	274 days (54·5 %)	237 days (50·4 %)	238 days (51·0 %)	222 days (48·8 %)	971 days (51·2 %)
Fat (en%)	265 days (52·7 %)	214 days (45·5 %)	225 days (48·2 %)	212 days (46·6 %)	916 days (48·3 %)
SFA (en%)	139 days (27·6 %)	102 days (21·7 %)	129 days (27·6 %)	91 days (20·0 %)	461 days (24·3 %)
Carbohydrates (en%)	133 days (26·4 %)	93 days (19·8 %)	111 days (23·8 %)	92 days (20·2 %)	429 days (22·6 %)
Fibre (g)	142 days (28·2 %)	109 days (23·2 %)	102 days (21·8 %)	84 days (18·5 %)	437 days (23·1 %)
Alcohol (en%)	338 days (67·2 %)	295 days (62·8 %)	267 days (57·2 %)	294 days (64·6 %)	1194 days (63·0 %)
Physical activity					
Stepcount	367 days (41·0 %)	418 days (49·8 %)	380 days (46·9 %)	325 days (40·8 %)	1490 days (44·6 %)
MVPA (min/week)	125 participants (96·2 %)	117 participants (97·5 %)	109 participants (96·5 %)	110 participants (96·5 %)	461 participants (96·6 %)
Sedentary behaviour					
Sedentary time (h)	227 days (25·3 %)	231 days (27·5 %)	259 days (31·9 %)	221 days (27·8 %)	938 days (28·1 %)
Sleep					
Sleep efficiency (%)	306 nights (30·1 %)	283 nights (30·1 %)	255 nights (29·3 %)	310 nights (34·5 %)	1154 nights (31·0 %)

MVPA, moderate-to-vigorous physical activity.
*Day-level health recommendations were defined as protein intake ≥15 and ≤25 En%; total fat intake ≥20 and ≤30–35 En%; saturated fat intake <10 En%; carbohydrate intake ≥50–55 En%; fibre intake ≥25 g/d[42]; alcohol intake =0 En%; step count ≥10 000 steps/day[43]; sedentary time ≤8 h/d[44] and sleep efficiency ≥85 %[45]. PA guidelines were defined as ≥150 min/week of MPA, ≥75 min/week of VPA or a combined total of ≥150 min/week calculated as [MPA + (2 × VPA)][46].

Table 4. Descriptive statistics of the EMA items

	Burst 1		Burst 2		Burst 3		Burst 4		Total	
Item	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Pain	8·6	16·2	8·9	14·9	8·7	14·5	8·6	15·7	8·7	15·4
Relaxation	5·4	1·2	5·4	1·2	5·4	1·1	5·4	1·1	5·4	1·2
Satisfaction	5·5	1·0	5·5	1·0	5·5	0·9	5·6	0·9	5·5	1·0
Cheerfulness	5·2	1·1	5·3	1·1	5·3	1·0	5·3	1·0	5·3	1·1
Positive emotions	5·4	0·9	5·4	1·0	5·4	0·9	5·4	0·9	5·4	0·9
Loneliness	1·6	0·9	1·6	0·9	1·6	0·8	1·6	0·8	1·6	0·8
Anxiety	1·6	0·8	1·6	0·8	1·6	0·8	1·6	0·9	1·6	0·8
Feeling down	1·8	1·0	1·8	1·0	1·8	1·0	1·8	1·0	1·8	1·0
Negative emotions	1·7	0·8	1·7	0·7	1·7	0·7	1·7	0·8	1·7	0·8
Stress	2·2	1·2	2·3	1·2	2·2	1·2	2·2	1·2	2·2	1·2
Fatigue	2·8	1·6	2·8	1·5	2·9	1·6	2·8	1·6	2·8	1·6
Intention										
Physical activity	4·7	1·9	4·7	1·9	4·6	1·9	4·6	2·0	4·7	1·9
Sedentary behaviour	4·4	1·9	4·6	1·9	4·6	1·9	4·4	1·9	4·5	1·9
Dietary intake	5·1	1·6	5·2	1·5	5·3	1·5	5·2	1·5	5·2	1·5
Self-efficacy										
Physical activity	5·0	1·8	5·0	1·8	5·0	1·8	4·8	1·8	5·0	1·8
Sedentary behaviour	4·7	1·9	4·9	1·8	4·9	1·8	4·7	1·8	4·8	1·8
Dietary intake	5·3	1·5	5·5	1·4	5·4	1·4	5·3	1·4	5·4	1·4
Social context: alone	35·1 %		34·5 %		33·5 %		33·0 %		34·1 %	
Social context: not alone	64·9 %		65·5 %		66·5 %		67·0 %		65·9 %	

(*Continued*)

https://doi.org/10.1017/S0007114526108526 Published online by Cambridge University Press

Table 4. (*Continued*)

Item	Burst 1		Burst 2		Burst 3		Burst 4		Total	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Physical context: inside	87·1 %		76·1 %		74·9 %		87·0 %		81·4 %	
Home	77·8 %		76·0 %		78·0 %		75·3 %		76·8 %	
Work	6·4 %		7·2 %		7·4 %		5·4 %		6·6 %	
Home of relatives/friends	5·0 %		5·4 %		4·5 %		6·2 %		5·3 %	
Shop	0·9 %		1·2 %		1·1 %		1·1 %		1·1 %	
Catering facility	1·9 %		2·5 %		1·9 %		2·6 %		2·2 %	
Public space	2·6 %		2·0 %		1·4 %		2·5 %		2·2 %	
Sports hall	1·0 %		0·7 %		0·2 %		0·9 %		0·7 %	
On the go	1·4 %		1·9 %		1·8 %		1·7 %		1·7 %	
Other	3·1 %		3·2 %		3·7 %		4·2 %		3·5 %	
Physical context: outside	12·9 %		23·9 %		25·1 %		13·0 %		18·6 %	
Natural environment	25·7 %		21·8 %		18·1 %		32·1 %		23·0 %	
Built environment	32·7 %		18·9 %		18·2 %		31·9 %		23·4 %	
Private environment	21·1 %		46·7 %		51·2 %		19·0 %		38·8 %	
Other	20·4 %		12·6 %		12·5 %		17·1 %		14·8 %	

EMA, ecological momentary assessment.
*All items had a response range of 1–7 except for the pain measure, which ranged from 0 to 100.

and fatigue of 8·7, 2·2 and 2·8 (SD = 15·4, 1·2 and 1·6), respectively. Mean values for intention and self-efficacy ranged from 4·5 to 5·4. Regarding social and physical context, participants were alone in 34·1 % of assessments, and indoors in 81·4 % of cases, most often at home (76·8 %).

At the group level, descriptive statistics provide an overview of behaviours (Table 2) and determinants (Table 4) across the four measurement bursts. For example, mean daily step count ranged from 9986 steps in the first burst to 11 284 steps in the second, 10 839 steps in the third and 10 371 steps in the fourth burst. The day-level dashboard reveals additional insight into weekday-specific patterns. Within the 1st burst, for instance, mean step count differed by weekday, with 9350 steps on Monday, 9893 on Wednesday and 10 641 on Saturday. The interactive dashboard enables further exploration of such day-level patterns: https://burst-analytics-sbsm.onrender.com/.

Discussion

To our knowledge, this is the first observational study with a measurement burst design to simultaneously collect data on dietary intake, PA, SB, sleep and determinants in adults aged 55 to 75 years over a 12-month period. The present paper aimed to (1) evaluate the feasibility of the study protocol by describing the study design and methodology, assessing participant compliance and dropout, and reflecting on challenges and lessons learned and (2) provide a descriptive overview of group-level and day-level patterns of behaviours and determinants across the bursts.

Patterns of behaviours and determinants

Group-level patterns of behaviours and determinants showed only limited variation across the four bursts, raising the question of whether multiple bursts are necessary. However, the day-level dashboard revealed that aggregating data may obscure meaningful fluctuations that only become visible at finer timescales. Moreover, group-level stability does not guarantee that patterns within individuals remain stable over time. Additional fluctuations may appear at even more fine-grained timescales (e.g. within-day dynamics), or at the person-level, where subgroup differences and within-person fluctuations may diverge from group-level statistics. Although an in-depth exploration of the dataset's longitudinal structure is beyond the scope of this paper, future analyses using the full temporal hierarchy and multiple person-levels will allow a more detailed examination of temporal dynamics and within-person variability.

The differences between aggregated and day-level patterns also become clear when examining adherence to health recommendations. The low adherence rates stand in contrast to the relatively favourable mean values. For instance, although mean energy intake was relatively low (1692 kcal) and mean protein intake (16·4 En%) fell within the advised 15–25 En%, dietary intake quality at the macronutrient level deviated frequently from guidelines. Daily protein intake met the recommendation on only 51·2 % of days, and fat intake fell within the recommended 20–35 En% on 48·3 % of days. Adherence was considerably lower for SFA (<10 En%; 24·3 % of days), carbohydrate intake (50–55 En%; 22·6 % of days) and fibre intake (≥25 gram/day; 23·1 % of days). These discrepancies highlight that labelling a study sample as 'healthy' based solely on mean values is misleading, as such statements can only be substantiated by comparing adherence rates.

Feasibility of the study protocol by assessing participant compliance and drop out

Regarding feasibility, findings demonstrated high participant compliance, even when combining multiple measurement

https://doi.org/10.1017/S0007114526108526 Published online by Cambridge University Press

instruments. Overall, 89·2 % of participants completed all measurement bursts, with most attrition occurring after the first burst. This suggests that once participants became familiar with the study protocol, those who continued were both willing and able to adhere to it. Compliance with the smartphone applications was generally high, reinforcing evidence that older adults can effectively use applications when provided with clear guidance[38]. For the time-based EMA questionnaires specifically, Figures 4 and 5 showed only limited variation in compliance across study days and time blocks, indicating relatively stable compliance across bursts. Given that missing data are common in EMA studies due to the intensive and repeated assessments over time[12], these findings suggest that participant engagement was successfully maintained throughout the study period.

To better understand the high level of feasibility, it is important to consider the factors that may have facilitated such high compliance. A first explanation may be the precautions that were implemented to minimise participant burden. First, a measurement burst design was used, incorporating 12-week intervals without measurements to prevent sustained measurement fatigue. Second, EMA surveys were limited to six brief prompts per day. Third, dietary intake reporting was restricted to 4 days. A second explanation may be the support provided by the research team during the measurement bursts. Participants occasionally contacted the researchers with questions or technical difficulties, particularly during the first burst. Because multiple participants were enrolled simultaneously, individual support requests occurred on an almost daily basis during this period, although most participants did not require frequent assistance. The need for support decreased substantially in subsequent bursts as participants became more familiar with the procedures. A third explanation relates to the characteristics of the study sample. Convenience sampling resulted in an overrepresentation of women, highly educated individuals and relatively healthy and digitally literate participants. This sampling bias may have contributed to the high compliance and low dropout and limits the generalisability of the findings to the broader older adult population. Therefore, similar compliance rates may not necessarily be expected in a more representative sample, particularly among, for example, individuals with lower digital literacy. Previous EMA research has demonstrated that compliance may vary according to participant characteristics, with lower compliance observed among older adults and individuals with less experience using smartphone technology[38–40]. Further, no financial incentives were provided. Instead, participants received a personalised report summarising their individual and overall study findings. While this non-financial incentive may have supported engagement, it may also have reinforced sampling bias by particularly attracting individuals who were already interested in health-related topics. However, given the innovative nature of this study, the priority was on accurately capturing participants' daily lives and ensuring some diversity, rather than achieving population representativeness. Specifically, minimising non-compliance and missing data was essential, as both lead to an inaccurate representation of an individual's daily life[41]. Future research should examine the protocol in a representative sample to further assess its feasibility and generalisability.

Throughout the study, several challenges were encountered and addressed, providing valuable lessons for future research. The use of the SEMA^3-application resulted in recurrent technical issues. Therefore, the research team developed a document summarising the most common problems and corresponding solutions to support participants. Additionally, compliance was monitored via the SEMA^3 dashboard, allowing rapid identification of low response rates and enabling researchers to proactively contact participants when issues were detected. Finally, when notification sounds failed, participants received the prompt schedule and advised to set smartphone alarms.

From the start of the first burst, it became clear that accurately reporting dietary intake was challenging for many participants. Participants occasionally omitted food items or reported incorrect portion sizes (e.g. entering six whole cauliflowers instead of six cauliflower florets)[30]. This was mainly caused by limited awareness of how to record food intake adequately, insufficient knowledge of food composition and habitual, automatic dietary intake. To improve data quality, several measures were implemented. First, an additional practice exercise was provided at the start of the second burst. Second, when specific food items were unavailable in the application, participants were instructed to select the closest matching food item. Third, when entries were forgotten, participants were instructed to make notes for later digital entry. Fourth, researchers verified the food records carefully before the second appointment and reviewed entries together with participants to correct inaccuracies. These experiences highlight the importance of not over-estimating participants' prior knowledge of dietary recording, as accurate logging is not self-evident for everyone.

Finally, an overarching lesson concerned the value of a personalised and participant-centred approach. Tailoring the location and timing of the appointments in consultation with participants, and maintaining regular contact, appeared to support engagement and study progression. Based on researcher observations, this individualised approach contributed to participant adherence and overall compliance.

Strengths and limitations

This study has several strengths. First, it adopted a more holistic perspective by simultaneously collecting data on diet, PA, SB, sleep and their determinants in adults aged 55–75 years. Second, the measurement burst design enabled 28 days of objective, detailed behavioural monitoring throughout the year, combined with time-based EMA, without overburdening participants. This facilitated a shift from low- to high-resolution assessments. Third, the design enables analyses at both group- and individual-levels, and this paper has already reported detailed group-level descriptives. However, two implementation-related limitations of the measurement burst design should be acknowledged. First, although bursts were scheduled approximately 12 weeks apart, the intervals between bursts were not exactly identical for all participants. This may have introduced some heterogeneity in the timing of repeated assessments and should be considered in future longitudinal analyses. Second, participants did not all start their 7-day measurement period on the same day of the week. Consequently, the correspondence between study days (days 1–7) and calendar days (Monday–Sunday) varied across participants. For example, dietary intake was assessed on days 1, 3, 5 and 7, resulting in variation in the weekdays covered across participants. Nevertheless, strict standardising of both the start day and the exact interval between bursts was not feasible within the real-world context of the study.

Conclusion

In conclusion, this paper demonstrated the feasibility of studying MHB in adults aged 55–75 years by combining dietary assessment, accelerometery and time-based EMA within a measurement burst design. Even with the protocols' complexity, participant compliance was high, likely supported by efforts to minimise

https://doi.org/10.1017/S0007114526108526 Published online by Cambridge University Press

participant burden, although sampling bias may have affected this. Across the four bursts, group-level patterns of behaviours and determinants showed limited variation, yet day-level visualisations revealed more pronounced variability, illustrating how aggregated data can mask meaningful temporal dynamics. The contrast between the relatively favourable mean values and rather low day-level adherence to health recommendations further underscores the added value of examining behaviours and determinants in more detail. Although an in-depth exploration of the dataset's rich longitudinal structure fell beyond the scope of this paper, future analyses using the full temporal hierarchy and multiple person-levels will allow more detailed examination of temporal dynamics and within-person variability.

Supplementary material. To view supplementary material for this article, please visit https://doi.org/10.1017/S0007114526108526

Data availability statement. All documents, datasets and scripts referenced in this paper and generated as part of the research project 'Leefwijzer 55+' are available in the Open Science Framework repository: https://doi.org/10.17605/OSF.IO/GR2K6.

Acknowledgements. The authors would like to thank Dr. Ruben De Blaere for his valuable assistance with programming and all participants of the study for their volunteering.

Author contributions. **K.C.:** Conceptualisation-Equal, Data curation-Lead, Formal analysis-Lead, Funding acquisition-Equal, Investigation-Lead, Methodology-Equal, Project administration-Lead, Resources-Equal, Visualisation-Lead, Writing – original draft-Lead; **L.M.:** Supervision-Equal, Writing – review & editing-Equal; **F.D.B.:** Funding acquisition-Supporting, Supervision-Equal, Writing – review & editing-Equal; **F.O.:** Funding acquisition-Supporting, Supervision-Equal, Writing – review & editing-Equal; **D.V.D:** Conceptualisation-Equal, Funding acquisition-Equal, Methodology-Equal, Supervision-Lead, Writing – review & editing-Lead.

Financial support. This work was supported by the Research Foundation Flanders (FWO) [grant number 1120725N].

Competing interests. The author(s) declare none.

References

1. WHO (2022) WHO European regional obesity report 2022.
2. Branca F, Nikogosian H, Lobstein T (2007) *The challenge of obesity in the WHO European Region and the strategies for response: summary: World Health Organization*. Copenhagen, Denmark: WHO Regional Office for Europe.
3. Blüher M (2019) Obesity: global epidemiology and pathogenesis. *Nat Rev Endocrinol* **15**, 288–298.
4. Heymsfield SB & Wadden TA (2017) Mechanisms, pathophysiology, and management of obesity. *N Engl J Med* **376**, 254–266.
5. Prochaska JJ, Velicer WF, Nigg CR, *et al.* (2008) Methods of quantifying change in multiple risk factor interventions. *Prev Med* **46**, 260–265.
6. Heino MTJ, Knittle K, Noone C, *et al.* (2021) Studying behaviour change mechanisms under complexity. *Behav Sci* **11**, 77.
7. Dunton GF (2018) Sustaining health-protective behaviors such as physical activity and healthy eating. *Jama* **320**, 639–640.
8. Chevance G, Perski O & Hekler EB (2021) Innovative methods for observing and changing complex health behaviors: four propositions. *Transl Behav Med* **11**, 676–685.
9. Štefan L, Petrinović L, Sporiš G, *et al.* (2018) Frequency of dietary intake and physical activity in older adults: a cross-sectional study. *Nutrients* **10**, 1960.
10. Sliwinski MJ (2008) Measurement-burst designs for social health research. *Soc Pers Psychol Compass* **2**, 245–261.
11. Stawski RS, MacDonald SW & Sliwinski MJ (2015) Measurement burst design. *Enc Adulthood Aging*, 1–5.
12. Myin-Germeys I & Kuppens P (2026) *The Open Handbook of Experience Sampling Methodology-: A Step-by-Step Guide to Designing, Conducting and Analysing ESM Studies*: Leuven, Belgium: Leuven University Press.
13. Brewster PW, Rush J, Ozen L, *et al.* (2021) Feasibility and psychometric integrity of mobile phone-based intensive measurement of cognition in older adults. *Exp Aging Res* **47**, 303–321.
14. Van der Heyden J, Renard F & Scohy A (2019) *Belgisch gezondheidsonderzoek 2018. 2019/14.440/89*. Brussels, Belgium: Sciensano.
15. Gobbens RJ, Boersma P, Uchmanowicz I, *et al.* (2020) The Tilburg Frailty Indicator (TFI): new evidence for its validity. *Clin Interv Aging* **15**, 265–274.
16. O'Brien S, Dozo N, Hinton J, *et al.* (2024) SEMA3: A free smartphone platform for daily life surveys. *Behav Res Methods* **56**, 7691–7706. https://doi.org/10.3758/s13428-024-02445-w.
17. Lucassen DA, Brouwer-Brolsma EM, Boshuizen HC, *et al.* (2023) Validation of the smartphone-based dietary assessment tool "Traqq" for assessing actual dietary intake by repeated 2-h recalls in adults: comparison with 24-h recalls and urinary biomarkers. *Am J Clin Nutr* **117**, 1278–1287.
18. Nicolas Bouckaert SG, Devriese S & Cleemput I (2021) *Een Belgische waardenset voor de EQ-5D-5L.– hoe gezondheidsgerelateerde levenskwaliteit waarderen?. Health Services Research (HSR)*. KCE Reports 342. Brussel: Federaal Kenniscentrum voor de Gezondheidszorg (KCE). https://doi.org/10.57598/R342AS.
19. Lucassen DA, Brouwer-Brolsma EM, van de Wiel AM, *et al.* (2021) Iterative development of an innovative smartphone-based dietary assessment tool: Traqq. *J Vis Exp* **169**, 62032.
20. Seeuws C (2017) Belgian branded food products database: inform consumers on a healthy lifestyle in a public-private partnership. *J Food Compos Anal* **64**, 39–42.
21. Eslinger D, Rowlands AV, Hurst TL, *et al.* (2011) Validation of the GENEA Accelerometer.
22. Kozey-Keadle S, Libertine A, Lyden K, *et al.* (2011) Validation of wearable monitors for assessing sedentary behavior. *Med Sci Sports Exerc* **43**, 1561–1567.
23. Maes I, Mertens L, Poppe L, *et al.* (2023) Within-person associations of Accelerometer-assessed physical activity with time-varying determinants in older adults: time-based ecological momentary Assessment Study. *JMIR aging* **6**, e44425.
24. Maes I, Mertens L, Poppe L, *et al.* (2022) The variability of emotions, physical complaints, intention, and self-efficacy: an ecological momentary assessment study in older adults. *PeerJ* **10**, e13234.
25. Cnudde K, De Vylder F, Cardon G, *et al.* (2024) Within-and between-person associations of time-varying determinants with snacking in older adults: an EMA study. *Br J Nutr* **132**, 1–31.
26. Michie S, Van Stralen MM & West R (2011) The behaviour change wheel: a new method for characterising and designing behaviour change interventions. *Implement Sci* **6**, 1–12.
27. Delobelle J, Compernolle S, Vetrovsky T, *et al.* (2025) Contexts, affective and physical states and their variations during physical activity in older adults: an intensive longitudinal study with sensor-triggered event-based ecological momentary assessments. *Int J Behav Nutr Phys Act* **22**, 30.
28. Meijboom S, van Houts-Streppel MT, Perenboom C, *et al.* (2017) Evaluation of dietary intake assessed by the Dutch self-administered web-based dietary 24-h recall tool (Compl-eat™) against interviewer-administered telephone-based 24-h recalls. *J Nutr Sci* **6**, e49.
29. Lucassen DA, Brouwer-Brolsma EM, Slotegraaf AI, *et al.* (2022) DIetary ASSESSMENT (DIASS) STUDY: design of an evaluation study to assess validity, usability and perceived burden of an innovative dietary assessment methodology. *Nutrients* **14**, 1156.
30. Ambrus Á, Horváth Z, Farkas Z, *et al.* (2013) Pilot study in the view of a Pan-European dietary survey–adolescents, adults and elderly. *EFSA support publ* **10**, 508E.
31. Willett W (2012) *Nutritional Epidemiology*, 3rd ed. New York: Oxford University Press.
32. van Hees V, Sabia S, Patterson M, *et al.* (2026) GGIR: Raw Accelerometer Data Analysis.
33. Dillon CB, Fitzgerald AP, Kearney PM, *et al.* (2016) Number of days required to estimate habitual activity using wrist-worn GENEActiv accelerometer: a cross-sectional study. *PLOS ONE* **11**, e0109913.

https://doi.org/10.1017/S0007114526108526 Published online by Cambridge University Press

34. Van Dyck D, Herman K, Poppe L, *et al.* (2019) Results of MyPlan 2.0 on physical activity in older Belgian adults: randomized controlled trial. *J Med Internet Res* **21**, e13219.
35. Morris AS, Murphy RC, Shepherd SO, *et al.* (2019) A multi-component intervention to sit less and move more in a contact centre setting: a feasibility study. *BMC Public Health* **19**, 1–17.
36. Winkler EA, Bodicoat DH, Healy GN, *et al.* (2016) Identifying adults' valid waking wear time by automated estimation in activPAL data collected with a 24 h wear protocol. *Physiol Meas* **37**, 1653.
37. Vachon H, Viechtbauer W, Rintala A, *et al.* (2019) Compliance and retention with the experience sampling method over the continuum of severe mental disorders: meta-analysis and recommendations. *J Med Internet Res* **21**, e14475.
38. Compernolle S, Vetrovsky T, Maes I, *et al.* (2024) Older adults' compliance with mobile ecological momentary assessments in behavioral nutrition and physical activity research: pooled results of four intensive longitudinal studies and recommendations for future research. *Int J Behav Nutr Phys Act* **21**, 92.
39. Yao L, Yang Y, Wang Z, *et al.* (2023) Compliance with ecological momentary assessment programmes in the elderly: a systematic review and meta-analysis. *BMJ open* **13**, e069523.
40. Sun Y, Jaiswal A, Slade C, *et al.* (2025) Associations between social determinants of health and adherence in mobile-based ecological momentary assessment: scoping review. *J Med Internet Res* **27**, e69831.
41. Wang S, Intille S, Ponnada A, *et al.* (2022) Investigating microtemporal processes underlying health behavior adoption and maintenance: protocol for an intensive longitudinal observational study. *JMIR Res Protoc* **11**, e36666.
42. Gezondheidsraad H (2016) *Voedingsaanbevelingen voor België - 2016*, vol. Advies nr. 9285. Brussel: HGR.
43. Ding D, Nguyen B, Nau T, *et al.* (2025) Daily steps and health outcomes in adults: a systematic review and dose-response meta-analysis. *Lancet Public Health* **10**, e668–e681.
44. Stamatakis E, Ekelund U, Ding D, *et al.* (2019) Is the time right for quantitative public health guidelines on sitting? A narrative review of sedentary behaviour research paradigms and findings. *Br J Sports Med* **53**, 377–382.
45. Ohayon M, Wickwire EM, Hirshkowitz M, *et al.* (2017) National Sleep Foundation's sleep quality recommendations: first report. *Sleep health* **3**, 6–19.
46. Bull FC, Al-Ansari SS, Biddle S, *et al.* (2020) World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med* **54**, 1451–1462.

https://doi.org/10.1017/S0007114526108526 Published online by Cambridge University Press