



**Life
Course
Centre**

WORKING PAPER SERIES

No. 2023-21

October 2023

Understanding sleep routines

A novel mixed methods approach to understand promoters and barriers of healthy sleep

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Research Summary

Why was the research done?

Sleep is critical to health, wellbeing, and daily functioning. Therefore, measuring sleep, including promoters and barriers of healthy sleep is vital. However, there are few tools that allow for an in-depth assessment to capture the home sleep environment and personal routines, as well as changes to these routines, for individuals and families. Therefore, we developed a novel mixed method (qualitative and quantitative), semi-structured interview approach, which combined graphical elicitation and time use approaches to create a new measure of sleep and sleep routines.

What were the key findings?

In this paper, we outline the development of a mixed-method approach to capture individual and household level sleep routines. The key findings were: 1) Adherence, feasibility, and acceptability of the method was high, 2) Participants reported high enjoyment of the activity, and 3) the method led to increased accuracy and recall of the home sleep environment and sleep routines.

What does this mean for policy and practice?

There is high utility of this method for engaging with different target groups and demographics to explore sleep management behaviours and routines used by individuals and households. This approach will help to inform the development of new survey instruments and identify new potential interventions to improve sleep health.

Citation

Rossa, K., Pattinson, C.L., Edmed, S.L., Coles, L., Allan, A., & Smith, S.S. (2023). 'Understanding sleep routines: A novel mixed methods approach to understand promoters and barriers of healthy sleep', Life Course Centre Working Paper Series, 2023-21. Institute for Social Science Research, The University of Queensland.

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Acknowledgements/Funding Sources

We would like to acknowledge and thank the participants for their time and contributions to this work. This research was supported by the Australian Government through the Australian Research Council's Centre of Excellence for Children and Families over the Life Course (Project ID CE200100025). We would also like to thank Ms. Nadine Lorimer, and Mr. Louis de Waal for their contribution as research assistants to the conduct of this study.

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Sleep is critical to wellbeing and daily physical and mental performance (Buysse, 2014). However, advice and interventions to support sleep in healthy populations are underdeveloped (Irish et al., 2015). Although the biological need for sleep has been well characterised across the lifespan (e.g., Hirshkowitz et al., 2016), less is known about what strategies enable or hinder the attainment of 'quality' sleep. In everyday life, an individual's sleep schedule and routines are traded against the plethora of 24-hour lifestyle demands such as work schedules, family, social lives, fitness routines, recreation, and entertainment. While it is possible that individuals manage these pressures while still prioritising sufficient sleep, there is surprisingly limited descriptions of these every day, intuitive lifestyle adaptations across a large diverse range of people. Understanding that these lifestyle factors change across development, within and between demographic groups, and that there is an interplay between these socioecological determinants and biological sleep need, is a critical but currently missing aspect of sleep research.

An example of such differences in inputs to sleep quality may be seen when comparing young adult and older adult populations. In adolescent and emerging adult populations, bedtime procrastination (particularly in relation to digital media use) is emerging as a prominent factor influencing sleep timing, duration, and quality (Kroese et al., 2014). Adolescence and young adulthood are also developmental periods in which maturation of brain mechanisms underpinning cognitive self-regulation is occurring. As such, effective sleep management strategies provided to young adults need to be distinct in focus and emphasis from advice given to older adults, who may experience quite different environmental, lifestyle/social, and biological determinants of sleep. As such, a 'one size fits all' approach to sleep management discounts the natural variability inherent between individuals. Measuring the self-management of sleep between individuals, specific demographic groups, and across development may help to explain why relatively mild disruption to sleep from external stressors can precipitate or perpetuate long-term chronic sleep and health problems in some individuals, whilst having limited impact on others (Spielman & Glovinsky, 1991). Thus, improving our understanding of sleep practices will inform more targeted and less burdensome sleep support services. Such understanding requires the development of methods to appropriately elicit this information from different populations.

Predominant methods for examining pre-bed routines have typically centred on customized checklists of pre-bed activities (Harbard et al., 2016), or diary led approaches (e.g., Adam et al., 2007). These measures tend to focus on qualities or behaviours associated with the sleep period itself (e.g., timing, subjective ratings of quality). However, how time is spent *around* the sleep period may be as important as what happens during the night. Evidence suggests that social routines and rhythms of daily life are important for regulating the timing of our circadian rhythms (the internal 'body clock'), which in turn has implications for sleep timing, duration, and quality (Moss et al., 2015). For this reason, our research team chose to develop a methodology encompassing both qualitative (graphical and interview) and quantitative (timing and scale measurement) dimensions to drive the generation of rich behavioural and spatiotemporal data across these elements.

Graphical elicitation techniques are an emerging qualitative tool for prompting critical examination and comparison of experiences. This approach may be a useful means to generate reflection from participants about the activities they engage in surrounding the sleep period. Graphical elicitation includes strategies such as asking participants to co-create a diagram to provide clear and tangible prompts and constraints for the discussion. The approach allows participants to configure and structure their experience whilst retaining the flexibility to add options and considerations that have not been included by the researcher. Graphical elicitation techniques have been reported to be

feasible and acceptable in other contexts, including clinical cancer populations (Thygesen et al., 2011).

In behavioural psychology, several approaches for tracking time use and everyday activities have been developed. Experience sampling protocols ask participants to answer questions relating to their current activities and mindset at random intervals throughout the day. Time use diaries and the day reconstruction methods ask participants to diarise their day across set increments, classifying behaviour in terms of activity, location, social interactions, and emotions (Kahneman et al., 2014). These approaches utilise pragmatic techniques for capturing aspects of individual behaviours or feelings at varying time-points during the day; however, they have not previously been adopted in the context of sleep management. Further, none of these approaches fully allow the documentation of patterns in sleep and lifestyle routines across behavioural, cognitive, social, and emotional dimensions, and across space and time in a qualitative manner. As such, a novel approach is needed.

Evening routines and sleep management in daily life are complex and private experiences that do not have an established theoretical guiding framework. As such, we have adapted classical techniques of time use and graphical elicitation approaches, within a qualitative interview framework to provide a novel investigation of individual, environmental, and lifestyle factors associated with sleep health and management in daily life. This novel method incorporates 1) co-mapping of individuals' dwelling; 2) providing a range of visual stimuli (e.g., characters, activities, digital devices) to prompt participants to talk about their routines and sleep management strategies; and 3) providing a visual timeline, consisting of templated timecards, to temporally map out the evening routine across several time periods. These activities allow participants to provide a narrative structure on their, or their families', evening routine as situated within their own homes (Bravington & King, 2019; Mattingly, 1998). This approach aims to answer a range of research questions on patterns in use of space and time before bed, barriers, and enablers of sleep across various levels of the socioecological system, variations in sleep self-management practices, and other potential features of the evening routine.

Methodological approach

We designed a semi-structured interview, which centred around 1) a graphical elicitation component – a participant drawn simple 'birds-eye' map/diagram of their home, bedroom, and outdoor surrounds, and 2) time-use component – using the map of the home, participants were asked to discuss what happened in the home the night prior across specific time-periods, from approximately 5pm until when they went to bed, and how they felt in the morning upon waking.

Graphical Elicitation Component

Participants were asked to draw a basic floorplan of the inside spaces of their house and immediate external environment that may influence their sleep (a participant example is provided in Figure 1). Within the home, participants were asked to include features that contribute to the lighting, noise, and temperature profiles of their homes such as windows, lights, types of flooring, as well as any heating or cooling devices within their homes. External features include the location of neighbours, streetlights, morning and evening sun position, roads, bus stops or train stations, and public spaces such as parks immediately next to their homes.

To provide context to the graphical elicitation, interviewers began the interview by querying participants' perceptions of noise from surrounding roads, neighbours, and other public spaces, as well as what the lighting profiles (both artificial and natural) of the home were like throughout the day. Participants were also asked about their perceptions of safety and comfort while living in the

home, the quality of the build, who they share their home with, as well as other lifestyle and contextual aspects that may be relevant for their sleep and sleep routines.

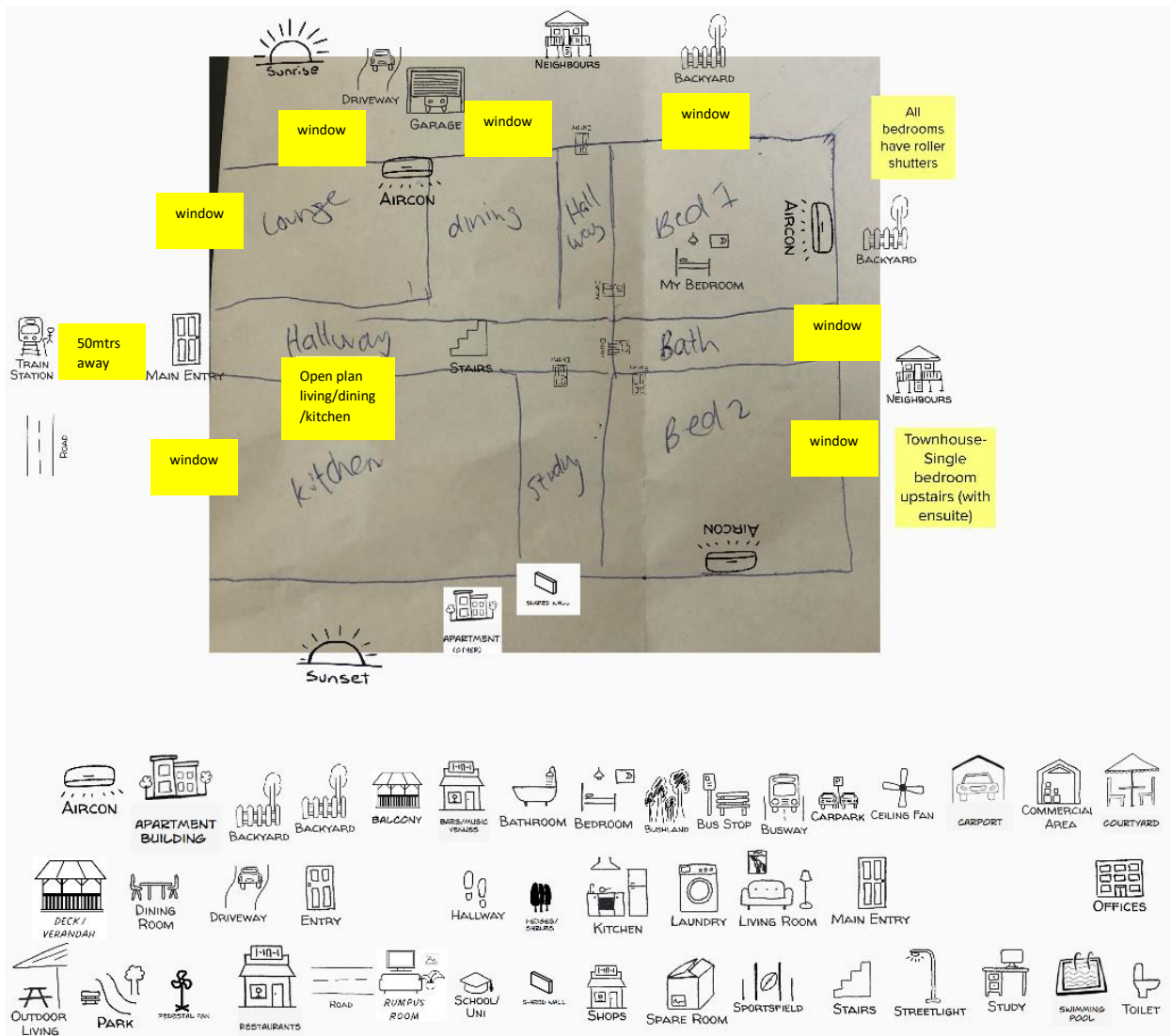


Figure 1. Example Floor Plan of a Participant

Time-use Component

Alongside the floorplan, a visual timeline of the evening hours was used as a temporal framework to elicit from participants the timing of key events and activities that occurred as part of the previous evening's routine leading up to sleep (see Figure 2). This *sequential* type of diagram is useful for recording the chronological pattern of events (Bravington & King, 2019). This process was conducted in the online platform Mural, an interactive whiteboard, allowing for visual diagramming, as well as placement of virtual 'sticky notes' and pictorial representations of objects or concepts anywhere on the screen.

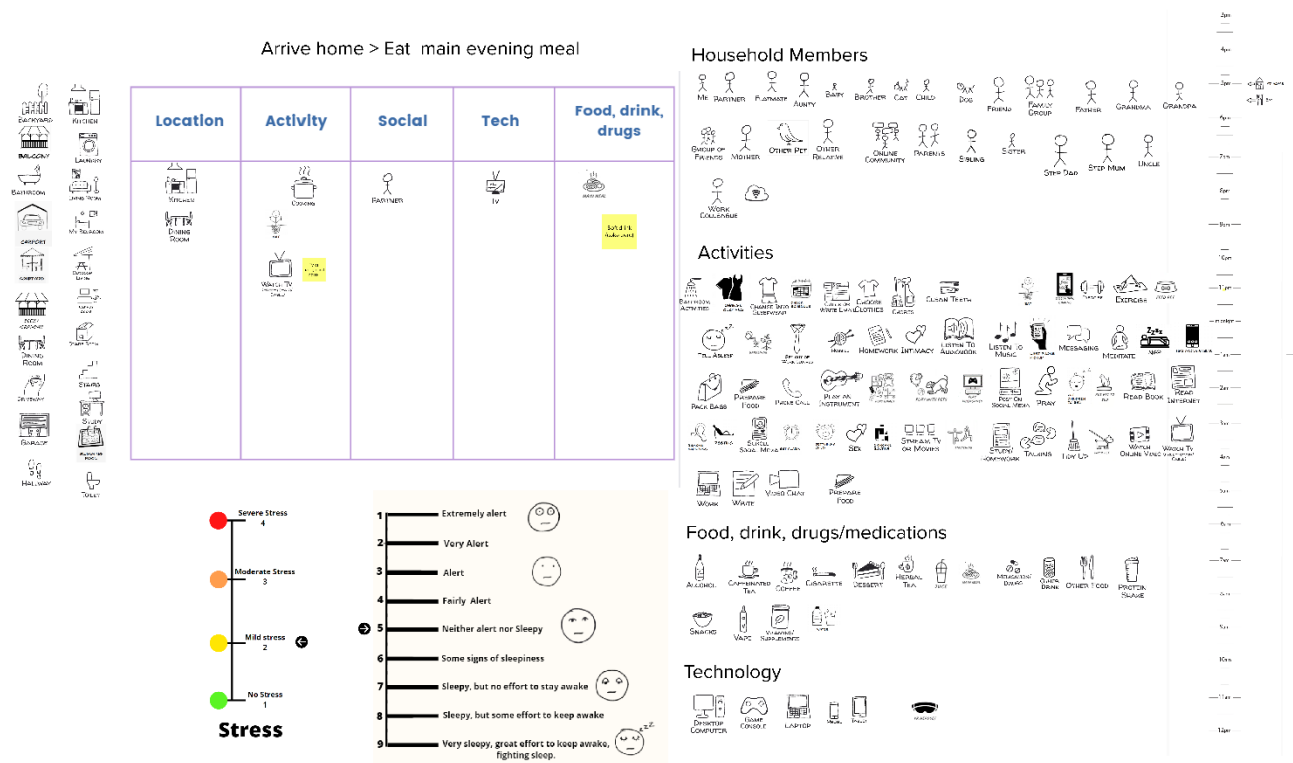


Figure 2. Example timecard of a participant with the icons available and rating scales. Participants instruct the interviewer what icons to select as they discuss what was happening during that time period.

Six ‘timecards’ corresponding with key activities (e.g., eating, watching tv, reading, exercising, cooking, scrolling social media, etc.) were also set up to temporally map the evening routine (see Figure 3). The timecards centred around the following periods: 1) arrive home [report movements from 17:00 onwards] – dinner; 2) finish dinner – get ready for sleep; 3) get ready for sleep – going to bed 4) Get into bed – Fall asleep; 5) Fall asleep – last wake up; 6) Final wake up – getting out of bed. These periods were chosen for their relevance to the lead up to sleep onset and were meant as anchors to help the participants recall events during specific blocks of time. However, the timecard cues were flexible and could be changed to suit participant’s individual routines (e.g., some participants did not eat dinner at home, so just went straight into sleep preparation activities). Thinking about the prior night, participants were taken through each timecard by in the interviewer. Each timecard consisted of a table for recording participant activities in any given timepoint, including their social and technological engagements, and whether they were consuming any food, beverages, or medications during that time block. Pictorial depictions of these activities/engagements were selected from a set of pre-made graphics and icons to aid as visual prompts, and additional notes could be added. Participants reported their subjective sleepiness and stress at each timepoint, except for timepoint 6. At timepoint 6 (wake up - getting out of bed), participants were asked to assess, on a 5-point Likert Scale, how refreshed they felt when they woke up, how they would rate their sleep quality, how synchronous last night’s activities and routines were compared to other members of their household, and how similar or different last night’s routine was compared to their usual routine. If participants indicated that their night was atypical, we asked that they describe the events of what their typical routine would be.

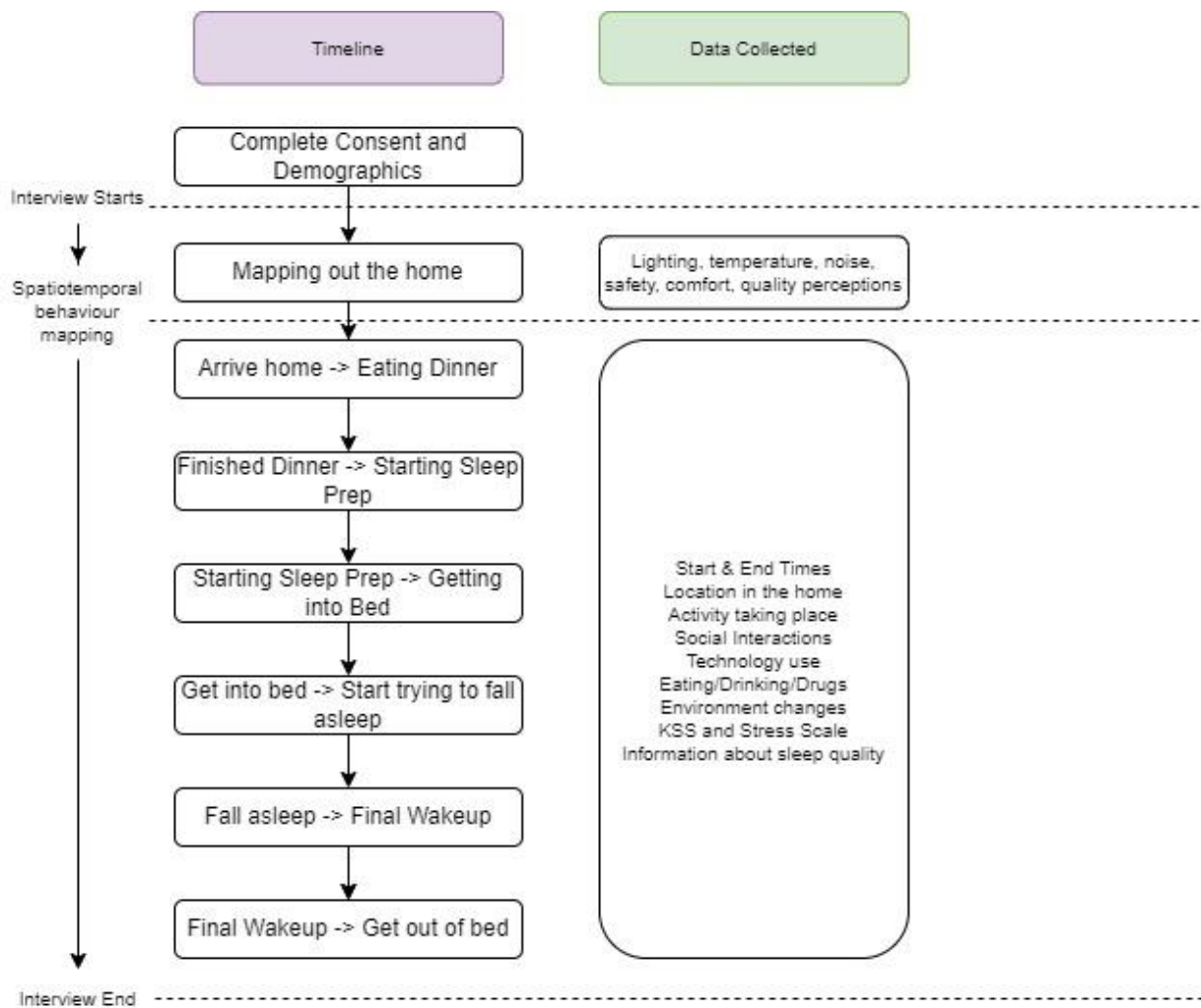


Figure 3. Participant timeline of activities completed throughout the study. KSS= Karolinska Sleepiness Scale

Evaluation

As this was a novel method for collecting sleep and sleep routine information, evaluation of participant experience was assessed. At the conclusion of the timecards, participants were asked a series of evaluation questions in which they were asked to rate on a 5-point scale, “Compared to a standard video interview, could you please rate how using the online whiteboard impacted...” 1) the detail of information provided, 2) accuracy of information you provided, 3) enjoyment of participating, and 4) ease of following along. Participants also had the option of completing the following short response question: “Could you please tell me about a benefit of this methodology, and a downside of this methodology?”

Adaption for online modes of administration

Originally, this study was planned and piloted to be conducted in person. This included the development and preparation of the following resources:

- Large timeline spanning an entire table.
- Physical placement of timeline anchors onto the tabletop timeline.
- Participants map/draw their house floorplan directly onto a whiteboard.
- Polymer ‘avatars’ were created and attached to magnets; Participant could choose an avatar (and one for each member of the household) and they were placed onto the map in the room where they were located at the start of each time block of the interview. These

avatars were moved around the map during the evening as participants described their routines (akin to playing a board game).

- Small coloured printed cards which pictorially depict potential activities (e.g. reading, listen to music, play instrument, cleaning teeth, exercise, praying, etc), social aspects (e.g. who was the person interacting with, social sport, gym, transit, etc), technology use (e.g. watching TV, scrolling, messaging, studying, working) and food/drink/drugs consumption are placed on separate boards related to each time block.

Each of these resources were meticulously created and crafted, which was time intensive. These resources were sturdy and able to be used easily within the pilot sessions and provided a novel, physical, and playful element to the interviews. Unfortunately, shortly after the study was established, in-person testing ceased due to COVID restrictions. As such, alternative methods of delivery were investigated.

An online (Zoom) recorded interview was determined to be the best approach by the research team. This method allowed for greater geographical dispersion of participants as they no longer had to come in physically to the laboratory. We were able to recruit rural and remote participants and could be agile to respond to government directions to limit movements and in-person contact (e.g., through COVID). However, the mapping of the houses and an interactive way to engage with the map was needed. The online platform Mural was trialled and provided the functionality required for the novel interactive mapping and time-use methods. All icons were able to be stored and depicted in the Mural platform. The online nature of delivery also significantly reduced the research costs associated with the study.

Participants

We recruited 31 young adults (aged 18 – 24 years) to test the feasibility and acceptability of the application of this method to elicit information about sleep and evening routines. Participants were recruited via flyers, university social media advertising, word of mouth, and snowballing. Inclusion criteria were young adults aged between 18 – 25 years, not currently experiencing any medically-diagnosed clinical sleep disorders.

Procedure

This project employed individual qualitative interviews conducted via zoom and the online interactive platform Mural. These semi-structured interviews took approximately 45 – 60 minutes to complete. Participants received a \$30 Coles e-Voucher as compensation for their time.

Upon recruitment, and following informed consent procedures, participants completed an online pre-interview questionnaire which captured information related to their demographic, dwelling, and sleep. Interviews were scheduled with participants predominantly via email. Participants were asked to provide an outline of their house (either hand-drawn, example provided in Figure 1, or where possible provide the floor plans) prior to the interview via email.

Each interview involved the collection of audio data and video data through Zoom, and graphical timeline data, including the “map of the house” through Mural. Following the interview, the audio and video files were downloaded. For quality assurance, each interview was reviewed by one of the interviewers, and any changes to the Murals were made accordingly, before exporting the Mural cards as pdf files.

Analysis

The audio files of each interview were transcribed using Google OneDrive's automated transcription feature before being reviewed and corrected by the interviewers. At each stage of the exports, participant information was deidentified. Once all transcripts and exports were generated, the audio and video files of the interviews were destroyed.

Participant demographic information was analysed using responses from the demographic questionnaire. The evaluation questions were only introduced following piloting of the study, therefore, 7 of the 31 participants did not receive the evaluation questions. Thus, 24 participants were provided the opportunity to evaluate the methods. Participants rated the detail, accuracy, enjoyment, and ease of following along on a 5-point Likert scale. However, due to the responses being recorded on a 5-point scale (shown in Figure 4), scores were combined for 1-2 (i.e. a score of 1 or 2 was coded as: less detailed/enjoyable/accurate and more difficult), 3 (responses of 3 remained the same), and 4-5 (i.e. a score of 4 or 5 was coded as: More detailed/enjoyable/accurate and easy to follow along) across each of the four questions. Finally, descriptions of the general themes for the short response question about the participant's perceptions of the benefit and downside of the methodology, were recorded by one of the authors, with group validation and editing conducted via group consensus.

Compared to a standard video interview, could you please rate how using this online whiteboard impacted....

<p>Detail of information provided</p> <p>5 Much more detailed information was collected</p> <p>4</p> <p>3 The same</p> <p>2</p> <p>1 Much less detailed information was collected</p> <p>→</p>	<p>Accuracy of information you provided:</p> <p>5 Much more accurate information was collected</p> <p>4</p> <p>3 The same</p> <p>2</p> <p>1 Much less accurate information was collected</p> <p>→</p>
<p>Enjoyment of participating:</p> <p>5 Much more enjoyable</p> <p>4</p> <p>3 The same</p> <p>2</p> <p>1 Much less enjoyable</p> <p>→</p>	<p>Ease of following along:</p> <p>5 Very easy to follow along</p> <p>4</p> <p>3 Neither easy nor difficult</p> <p>2</p> <p>1 Very difficult to follow along</p> <p>→</p>

Could you please tell me about a benefit of this methodology, and a downside to this methodology?

<p>Benefit: Being able to see what is being written down is helpful to fill in gaps</p>	<p>Downside:</p>
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Figure 4. Evaluation questions as presented on Mural to participants.

Results

Participants

Thirty-one participants completed the interviews. Participants were aged between 18 – 24 years (Mean = 22.1, SD \pm 1.6 years), 71% were female (23% were male, and 1 person was non-binary). Most participants (74%) were enrolled in formal education and/or were employed (84% in any type of employment i.e., casual, part-time, or full-time). In terms of household composition, 4 participants lived alone, and the remaining participants lived in households with between 1 and 6 other people. Participants reported living with a range of people including partners, children, siblings, parents, or flatmates. Participants reported living in a house (39%), unit/flat (39%), or a Townhouse/duplex (23%).

Feasibility and Acceptability

All participants were able to produce a map of their house. Interviews took between 33 and 66 minutes with the average time to complete the interviews being 50.4 minutes. Interviews focussed on the night prior and there was a similar number of weekday nights captured (Monday – Thursday; 58%) as weekend (Saturday and particularly Sunday) nights (42%). None of the interviews captured Friday night – due to both participant availability and researcher time schedules.

All participants offered the opportunity to evaluate the methods used responded. As such 100% (24) completed the evaluation survey. Overall, there was high agreement across participants (ratings of 4/5) that the online whiteboard format was accurate, detailed, enjoyable, and easy to follow. Specifically, compared to a standard video interview, participants rated that using the online whiteboard; was easy to follow along 96%, provided more detailed information 87.5%, was enjoyable 79.2%, and more accurate information was collected 75%.

Twenty-three of the 24 participants provided a short response to what they believed were the benefits of this methodology. These responses were categorised under four broad themes (please note that participant responses were able to be recorded under more than one category): strengths of visual aids/prompts (52.2%), interactivity (43.5%), convenience/ease of zoom and mural platform (21.7%), and efficient data collection (17.4%). Comments under the 'Strengths of the visual aids/prompts/timeline' theme included *"visual aid – seeing everything laid out and seeing icons/tables help prompt memories [and] improve accuracy"*, *"drawings are cute"*. And *"...Icons help to narrow down everything that happened in the day"*. The interactivity theme captures those who enjoyed being able to see and check that the interviewer understood them, making things more accurate and clearer for participants. For example, participants stated things like *"gets both interviewer and interviewee on the same page with understanding layouts"*, *"being able to see what is being written down is helpful to fill in gaps"*, and *"Makes it easier to follow interview process. It's more interactive"*. People also commented on the zoom/mural platform being convenient and easy for them, and how they felt that the methods were an *"efficient way to collect information using recordings and having visual diagrams"*.

Eight of the 24 participants reported on what they believed the 'downsides' of this methodology might be; three indicated accessibility could be an issue, i.e., using a small screen, or internet/technical difficulties; two were concerned that by capturing just the night before you might miss some of the diversity of activities or be missing some of the bigger picture; two thought that some participant control over the mural would be helpful to overcome communication issues; and, one participant was concerned that the methodology may be cumbersome for the interviewer later to go back and collate information.

Discussion

We developed and tested the use of a novel mixed-method technique where graphical elicitation was embedded within a semi-structured interview to capture sleep and sleep routines. Our results indicate that this method is feasible and showed high acceptability in this population. On average, interviews took approximately 50 minutes to complete. This novel combination of the house map and time-use capture helped to keep participants engaged throughout the interview period. This may be particularly important in populations which may be prone to 'Zoom fatigue' (Bailenson, 2021; Neshor Shoshan & Wehrt, 2022). Overall, participants were very positive about their experience using this method with almost all participants rating it as easy to follow along and enjoyable.

The novel combination of graphical elicitation and time use provided rich data which extends traditional qualitative interview techniques. The use of cues such as graphical elicitation is important as it can be challenging to spontaneously generate information about your experiences (Copeland & Agosto, 2012; Thygesen et al., 2011), even remembering each of the activities you conducted before bed last night can be difficult to recall spontaneously. The combination of mapping and time cues effectively facilitated memory recollection and prompted participant recall around each specific time frame. The graphical depiction of activities, time, and feelings, also allowed for real-time checking of the data by the participants. Participants were able to review the collection of the information and check or modify as needed throughout the entire process.

The online nature of delivery of this method did significantly reduce the research costs associated with the study. However, it is noted that some groups with limited experience with technology may find this method undesirable or challenging. Further development of this methodology with different groups is warranted. Another limitation of note is that some participants expressed the desire for more control over the Mural interface themselves and there was evidence of some miscommunication between the interviewer and interviewee in at least one instance. These frustrations were particularly pertinent for participants where English was a second language. As such, future studies should explore the efficacy of both the interviewer and interviewee being active contributors to the Mural board (or some other interface) to overcome such challenges.

Potential future research

Qualitative and quantitative analysis of these results are underway. The aim of this study was to gather pilot and feasibility data to underpin the development of a new self-report method describing sleep environments and routines. We have shown that this method is feasible and accessible, for targeting the sleep routines and environments of young adults. Testing in other populations, including families, and demographically diverse populations are planned and encouraged.

Conclusion

This method is designed to allow for the examination of patterns and attitudes towards sleep in daily life in a novel and detailed way, by constructing personal timelines of evening routines and identifying everyday sleep management strategies in healthy sleepers. This method has potential to be used across a variety of populations to address fundamental gaps in the literature about everyday sleep management behaviours, and the dimensions of sleep health that are important to the individuals.

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