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Assessing the use of a portable time-geographic diary for detecting patterns of daily occupations

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ABSTRACT

Background: A time-geographic diary approach is of interest in occupational therapy due to the inclusion of the diarist's subjective experiences. There are several methods for detecting doing in time, but details needed for analysis are still lacking. The smartphone application POrtable Diary Data collector (PODD), a 24-hr diary based on the time-geographic diary has recently been introduced.

Aim: To test the usability of PODD as a tool for diary data collection to detect and visualize sequences of daily activities.

Material and methods: An exploratory sequential design was used, where diary data was first collected and then followed by a questionnaire assessing usefulness. Thirty-one occupational therapy students participated. Usability testing was applied, exploring how participants experienced the use of the device. Data was analysed qualitatively and quantitatively.

Results: The PODD visually presents activity sequences and thus assists in detecting patterns of daily occupations (PDO). The students agreed on the supportive statements concerning learnability, efficiency and memorability. Regarding errors and satisfaction, participants agreed that the device was easy to use.

Conclusions: Using a mobile application to collect data about students' daily activities was effective. However, the PODD needs to be further evaluated among other groups and contexts as well as for its usefulness for PDO analyses.

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Introduction

There is a strong link between how people spend their time, i.e. what they do on a daily basis, and their health and well-being, which is evident throughout their life span [1]. Occupation is viewed as a universal phenomenon that is influenced by the environment or context in which it is performed [2]. In occupational therapy, an occupation is a subjective event in a perceived temporal, spatial and sociocultural condition, in contrast to an activity that is culturally defined and comprises a general class of human actions such as working, driving, or eating [3]. There are several areas within health care, where the individual's doings in everyday life are relevant. Occupational therapists, for example, enable the individual to identify and reflect on his or her everyday doing in order to empower change and adaptations towards a healthier everyday life [4,5]. There is, however, an urgent need for useful tools for detecting these patterns, which at the same time empower the individual to change into a healthier pattern.

The term occupation refers to activities performed by a specific individual in a certain environment, at a particular time, and with a meaning and purpose [6], such as, an individual who early one Monday morning drives to work. In contrast, the term activity is often used for what is being done, the action, (in this case driving and parking the car) regardless of the unique experiences and circumstances present on the specific occasion when the occupation is being performed. In time-geography [7], it is emphasized that the time during which an individual, when performing an activity, is located at a certain place may constrain as well as enable him or her to perform other desired activities within a given time frame, such as, a day. For example, the time it takes to move through

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space limits the possibilities to perform other activities later on and it may affect the activity sequence. In the basic time-geographic diary, data is collected about which activity is performed, when, at what place and with whom [7,8]. These aspects are regarded as contexts (activity context, geographical context and social context. Applying a time-geographic diary for data collection thus implies logging the daily occupations through operationalizing them to activities performed over time and in which contexts [8]. Presenting the diary to the diarist in the form of a graph visualizing the daily activity sequence, can lead to recognition of certain experiences and subjective feelings from the doing, i.e. the occupation [9]. This strategy can thus be a starting point for changing their patterns of daily occupation, a prerequisite for improvements.

The individuals' doings in time and place, and the patterns and subjective valuations that evolve from these, have been described by Erlandsson as 'patterns of daily occupations' [10] (PDO). There are, however, challenges in detecting PDO. In a study exploring the complexity in PDO, Erlandsson and Eklund [11] used four different methods (diary, observation, video and one for the study adapted, experience sampling method) to capture different aspects of PDO. For example, the study identified parallel doings, present in the same time frame. Such complexity is difficult to capture.

There are several ways to collect data about people's daily occupations. Most methods for collecting information about use of time for daily activities are concluded with the amount of time an average individual in the specific groups under study, use for various activities. It is common to work with standardized time-use diary forms with predefined time slots (usually 10 or 15 min) over the day, or with random 'ping machines' prompting each individual to write down what he or she did at the time of the prompt [12,13].

However, from the perspective of the unique individual, such average time-use figures are not very useful since the average is not valid for all. As part of an intervention aiming to strengthen the individual's resources for greater autonomy and involvement, the description must thus be based on the personal experiences of what the individual was doing, the specific individual's occupations.

To be better able to capture the full complexity in doing, it is important to record the doing as near the actual doing in time, as possible, which is encouraged by the time-geographic diary method [7,8]. Time-geography defines three types of constraints for the analysis of individual diaries: capacity (the individual's abilities and resources), authority (rules, laws andagreements) and coupling constraints (interdependencies in the time space) [14]. These are useful also for analyses of PDO. Coupling constraints influence an individual's PDO since the individual is constrained by the timing and location of activities of others, such as close family members and friends, as well as of other people in their formal roles, e.g. colleagues and service providers [7]. The individual's ability to do, and to change his or her doings is thus characterized by a multitude of factors. Orban and colleagues [15] collected time-geographic diaries from parents of children aged 4–6 years old with obesity, in order to study their PDO. Authority constraints were found in the study in rigid work schedules among parents who worked nightshift. Coupling constraints influencing the opportunities to organize family life were evident in most of the parents' PDO in the same study. The collected data were presented to the participants in the form of a time-geographic graph (space-time path). This strategy, enabling the parents' awareness by illustrating their own daily life in a time-geographic graph contributed to more time spent together in families. Awareness may be seen as a key element in the process of change to improve the PDO from a health and well-being perspective.

The time-geographic methodological frame of reference is regarded as useful and applicable for clinical practice since it views the individual as an indivisible unit and is based on information directly from the individual and thus providing opportunities for the individual to recognize his or her own day. However, the current prevalent approach for collection and coding of the time-geographic 24 h-diaries (using paper and pen methods) is time-consuming, which diminishes the extent of their use. There is thus a need for developing easy to apply and clinically useful methodologies for detecting and analysing PDO using a time geography framework. One example of such methodology was presented by Vrotsou et al. [16] who introduced a mobile application, i.e. a software designed to run on smartphones and other mobile devices, called PODD (for Portable Diary Data collection), which has the potential to increase the accessibility and usability of time-geographic diaries. The approach retains most of the advantages of a hand-written time-geographic diary (such as sequence, duration, location and social companionship) and it overcomes a number of the disadvantages of the paper and pen version of the method.

A similar app-based method (ADay) for collecting diary data, which has also been derived from the time-geographical diary approach, was used by Anaby et al. [17] when evaluating a tool for intervention. The intervention was aimed at encouraging young people with physical disabilities to increase their participation in social activities, and the intervention showed promising results. The usability of the ADay-app was, however, not tested in the study.

Portable diary data collection system (PODD)

The PODD is a time-geographic diary data collection approach utilizing smartphone technology, developed at Linköping University, Sweden [16]. PODD is a diary data collection system with the purpose of providing an effective, user-friendly and easily accessible data registration platform for the collection of diary data. It comprises a smartphone application for data registration and an accompanying web page for user registration and visualization of preliminary statistics on the collected data. PODD is designed to give little additional burden to the diarists during data collection, since a smartphone is a device that most people already carry.

PODD by default uses a slightly modified version of the pre-defined time-geographic diary categorization scheme [7] for registering the performed activities. The basic time-geographic diary instead allows the diarist to make free text entries, which demands manual coding of diary entries. The PODD makes it possible to collect directly usable and comparable diaries directly from diarists, which reduces the cost of manual coding.

The categorization scheme used in PODD has a hierarchical nature and comprises 5 levels of detail (LOD) for describing the activities [7,8,16]. The codes at the most general level of description correspond to eight general categories of daily life organization. These categories are: (1) Care for oneself, (2) Care for others, (3) Household care, (4) Leisure, (5) Transportation, (6) Food related activities, (7) Work and school, (8) Purchase activities. In the coding scheme each activity description at level $n+1$ is broken down into a more detailed description at level n; LOD 5 is the most general level while LOD 1 is the most detailed. For example, 'Transportation' at LOD 5 is broken down at LOD 4 to 'travel by car', 'travel by foot', 'travel by bicycle' etc. The coding scheme used for activity registration is interchangeable and extendable and thus if necessary, the smartphone application can be flexibly adjusted to the needs of a specific study.

The diarist can log in into the smartphone application and start collecting diary data once an account has been created (Figure 1(a)). The application user interface allows a diarist to fill in their diary by entering activities as they occur over the course of their day. The time stamp of the entry is saved as the start time of the activity for every activity entered. The activity remains active until the next activity is entered, thereby avoiding the problems related to predefined time slots. Hence, the start time and duration of the activity are recorded automatically in the PODD. Thereby, the sequential order and duration of the activities performed by the indivisible individual are revealed.

Figure 1. User interface of the PODD smartphone application. (a) Login page. (b) Application start page composed of (1) navigation and menu buttons, (2) main performed activity entry, (3) secondary activity entry, (4) additional variables describing the performed activity, such as place, companionship, and mood.

Figure 2. Process of entering activities using the PODD smartphone application. (a) Start page with main activity about to be updated. (b) First a selection between the 8 main categories of the coding scheme is made, e.g. Transportation, then (c) the selection is refined by scrolling down in the coding scheme to add more detailed activity descriptions, e.g. travel by car. (d) Additional variables describing the activity are specified, e.g. place is set to road. (e) Activity is set and (f) main page is updated.

The start page of the smartphone application shows a summary of the current status (Figure 1(b)). The main activity can be entered or altered on this page (Figure 1(b-2)) and a number of additional variables can be registered. These are: secondary activity (Figure 1(b-3)), location where the activity takes place, companionship during the activity, and mood while performing the occupation (Figure 1(b-4)).

The diarist enters an activity by searching through the activity coding scheme and selecting an appropriate activity. When a new activity is entered the diarist first chooses between the eight main categories of the coding scheme which are colour coded (Figure 2(b)). Activities are successively broken down into more detailed descriptions at each level of the hierarchical coding scheme (Figure 2(c)). After the activity has been entered additional contextual information for that activity, such as place, companionship, and mood, are collected in the interface as the diarist continues through the activity registration process (Figure 2(d)).

In addition to the main views for entering activities a complementary calendar view is also available in the PODD smartphone application. The calendar view allows the diarist to view the entered activity data and get a visualized overview of their patterns of daily occupations (Figure 3), and to make corrections, for example, adding activities that were not noted in the course of the day, or to correct mistakes.

The reason for currently testing PODD in this study is threefold. Firstly, as discussed in previous sections, many existing collection methods use prompting machines instead of full diaries. Or diaries with 10–15 min pre-set time intervals and coarse classifications in order to reduce the burden of filling in the diary, but at the cost of losing vital details that

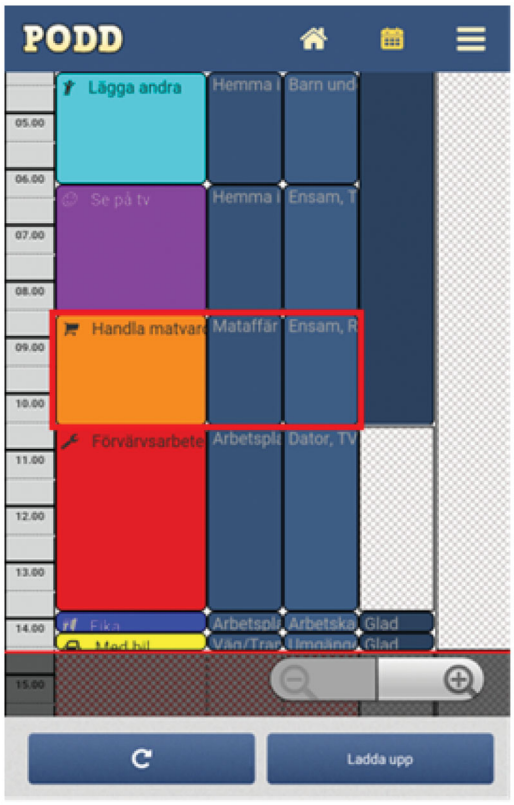

Figure 3. Calendar view of PODD displaying the start time and duration of activities performed (colour coded) as well as secondary activity and additional variables such as place, companionship, and mood (in blue).

can be crucial in an occupational therapy setting. Secondly, the time-geographic diary in its basic form applies free text entries of collected data on activity, time, place and companionship, which need to be post-processed and coded in order to be able to compare the diaries of different individuals who may report the same activity using different wordings. Thirdly, using time-geographic based visualizations (the calendar view seen in Figure 3) of the activity sequence of individuals, as provided by PODD, may be an important part of revealing their PDO and thereby motivate a change. The tool might also be important in designing and provide interventions directed to altering PDOs to enhance health.

The present study thus aims to test the usability of PODD as a tool for data collection in order to detect and visualize sequences of daily activities.

Material and methods

Design

We applied an exploratory sequential design [18] in this usability pilot study, with an initial phase of collecting time-geographic diaries with the PODD, followed by the completion of a questionnaire constructed for this study assessing users' attitudes and experiences. Occupational therapy students were selected as participants since they were assumed to be familiar with the PDO concept and motivated to test the mobile device. Students assessed product usability, clinical content and whether the application (PODD) was useful to detect and visualize activities in their sequences that are the basis for PDO. Usability is defined in this study as 'the extent to which a product can be used' [19]. The meaning of usability thus covers the interaction of person, task and environment.

Participants and context

The participants were students at the Occupational Therapy (OT) Programme at Lund University. OT students were chosen since they will be working with improving people's daily life, including health, and it is thus important for them to become familiar with methods that are relevant for describing and analysing PDO. The Occupational Therapy Programme is a three-year undergraduate programme. All students ($n = 94$) from the first year were invited to voluntarily take part in the study. The data collection took place between April 2016 and March 2017 and the students thus belonged to different cohorts. The eligibility criteria for participants were that they should own an android smart-phone or be willing to borrow one. Background information regarding age and gender was obtained. Table 1, shows an overview of the participants and collected data.

Procedure

Students were invited to participate *via* e-mail sent to all students ($n = 94$) in the first year of the occupational therapy programme. Only e-mail invitations were used since we wanted participation to be strictly voluntary. Students were informed in the e-mail about the PODD application and the purpose of the study. The PODD was free to download and students with an android smart phone could choose to download the PODD and guidelines how to use it. Students, who wished to borrow a smart phone, with a PODD installed, were given the opportunity to do so. Each participant was asked to use the PODD application to collect data from two weekdays and one weekend day. Participants were instructed to record when they started to perform each new activity during the 24 h. The start of a new activity indicates the end of the previous activity in order to capture PDO.

Table 1. Overview of participants and number of diaries uploaded.

Characteristics		Diaries (*n*)	Questionnaire
Age (years)	20 – 42		
median (md)	(26)		
Gender	31	75	20
Male	6	13	5
Female	25	62	15
Diaries collected			
Monday-Friday		51	
Saturday-Sunday		24	
Logged activities duration		2 – 291	
(minutes) (mean)		(37)	

Participants also indicated simultaneous performed activities, place, companion and experiences in the situation. The participants uploaded their diary to a server (database), where all data was stored, after recording 24 h. The purpose of the usability study was to test the diary data collection device PODD and consequently we did not analyse the diary data as such in this study. The usability study is instead based on the diarists' experiences using the PODD captured in a questionnaire.

Data collection

Participants used the smartphone application PODD to log their activities during three 24 h days. The participants were e-mailed a link to a questionnaire after uploading three diaries for their three days. The questionnaire, which was constructed specifically for this study, was inspired by the System Usability Scale (SUS), a standardized instrument designed to assess perceived usability [20,21]. Psychometric properties of the 10 items standard version of the SUS have been investigated according to its reliability, validity and sensitivity [22]. Showing the SUS to have reliabilities at or just over 0.90 and to be sensitive to differences among types of products [22]. The PODD questionnaire comprised 21 items indicating level of agreement or disagreement regarding perceived usability/ease-of-use and utility/design's functionality when using PODD. Quality assessment criteria were developed for the study. These were inspired by Nielsen's [23] qualitative approach for the evaluation of digital tools based on the five quality components of an application; learnability, efficiency, memorability, errors and satisfaction. Questions such as '*How quickly and efficiently is it to navigate?*' were posed. The items in the questionnaire were answered by using a five-point Likert-type scale [24] (1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree) and the opportunity to answer questions in an open-ended free text area was also provided. Further examples from the content of the questionnaire are given in Table 2 and in the results section.

Data analysis

The diary data and the questionnaires were registered electronically. Both diary data and the questionnaires were checked for errors prior to analysis. An exploratory sequential design proposed by Creswell [18], for analysing different sets of data, was used. Overall usability and the five quality components criteria of an application developed by Nielsen [23] were used when sorting the data from the questionnaires. These five quality categories are; Learnability, Efficiency, Memorability, Errors and Satisfaction.

The median (md), mean (m) and standard deviation (SD), were calculated to assess the participants' experience of using PODD in the quantitative descriptive analyses. The rationale for presenting median (md), mean (m) and standard deviation (SD) for each statement in the questionnaire using the five-point rating scale, was to present the result in greater detail, than is the case when only using the median. Open-ended questions were analysed qualitatively, using manifest content analysis [25]. Quotes were translated from Swedish to English in order to exemplify participants' experiences of use.

Ethical considerations

The study followed the principles for research involving human subjects and relevant paragraphs of the ethical principles of the Declaration of Helsinki for medical research [26]. All participants received information that they could participate voluntarily, were free to end their participation at any time and could decline to answer the questionnaire. Informed consent was presented in a written letter sent in an e-mail to the students. Individual students/participants agreed to participate prior to downloading the PODD, entering and uploading their data. In order to secure confidentiality according to the General Data Protection Regulation (GDPR) [27] all data collected was free from personal information i.e. the students only reported year of birth, gender and marital status. All data collected was treated confidentially.

Results

A slight majority of the students ($n = 31$), who registered and downloaded the application ($n = 58$),

Table 2. The participating students' ratings of the overall usability and the five quality components ($n = 20$).

Variables	Median	Mean	(SD)
Overall Usability			
Sense of confidence when using PODD*	5	4.2	(0.8)
Positive experience of using PODD as a diary	4	3.7	(0.8)
Logged days representative of their current everyday life	4	3.8	(0.8)
Learnability			
I think it is easy to learn and understand how to:			
Upload diary data	4	4.3	(0.8)
Use the start menu	5	4.4	(0.7)
Use the calendar function	4	3.9	(1.0)
Use the history function	4	4.3	(0.9)
Efficiency			
How quickly and efficient is it to navigate?			
Good overview and quick control*	5	4.3	(0.7)
Quick and easy to start using the PODD	5	4.3	(0.8)
Quick and easy interpretation of calendar function	4	3.7	(1.3)
Quick interpretation and use of history function	5	4.3	(0.9)
I think I would use it frequently*	3	3.1	(1.1)
Memorability			
Did you remember how to navigate in the application when starting up a new diary/activity?			
I needed to learn a lot before I could start using the PODD*	1	1.5	(0.9)
The application was complicated to use*	2	1.8	(0.9)
I think there were too many steps and inconsistencies in the application*	2	2.0	(0.8)
The application was easy to understand and use*	4	4.1	(0.8)
Errors			
Did you experience mistakes and needed technical support?			
Needed technical support to get started*	1	1.3	(0.6)
Experienced that I made mistakes*	2	2.1	(1.0)
Satisfaction			
How pleasant is it to use PODD?			
Easy to use not complicated at all	4	4.1	(0.8)
Most individuals (with or without disabilities) can certainly learn to use it*	4	3.7	(0.8)
Useful to see the PDO in the calendar function	5	4.3	(0.9)

Md = median, m = mean, SD = standard deviation. 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree. *Items inspired by the System Usability Scale (Brooke, 1996).

uploaded diaries with the PODD. The female students uploaded a total of 62 diaries and the male students uploaded 13 diaries (Table 1).

The participants were between 20 and 42 years old (md = 26). Fifty-one of the diaries were logged Monday-Friday, 24 diaries were logged Saturday-Sunday. The activities logged ranged from 2 min to 291 min ($m = 37$ min). Twenty ($n = 20$) of the participants answered the additional questionnaire (Table 1).

Overall usability

The participants' rating of their sense of confidence when using the PODD application was high (md = 5), and they generally found the application easy to use. They rated their experience of using PODD '*to document their day as positive*' (md = 4) and most of them agreed with the statement that '*their logged days were representative of their current everyday life*' (md = 4) (Table 2).

Learnability

How the participants experienced learnability and how easy it was for them to accomplish basic tasks when using the PODD application were assessed. The participants' rating indicated that they agreed that it was easy to learn and understand how to '*upload diary data*', '*use the calendar*' and '*history function*' (md = 4). They strongly agreed that '*the start menu was easy to use*' (md = 5).

Efficiency

The second quality category regarded how quickly the diarist can perform tasks, once they have learned its design. The statements that were strongly agreed upon (md = 5) were; '*it was quick and easy to start using the PODD*', '*good overview and quick control*' and '*quick interpretation and use of history function*'. The participants neither agreed nor disagreed about whether they '*would use the PODD frequently*' (md = 3). One participant stated that '*It was time consuming to find the correct ongoing activity*' and another '*There were too many actions to navigate through, it disrupted the rhythm of the day*'.

Memorability

Memorability referred to what extent the diarist needed a reminder in order to continue, after starting

to log a diary. An example of a question to capture memorability was: '*Did you remember how to use the application when starting up a new activity?*', Statements such as '*I needed to learn a lot before I could start using the PODD*' were strongly disagreed with (md = 1), '*the application was complicated to use*' and '*I think there were too many steps and inconsistency in the application*' were disagreed with (md = 2).

Participants added comments such as, '*it would be good to get a reminder to log a new activity*' and '*would be good with a reminder to stop an on-going secondary activity*', in the free text space. However, most participating students agreed upon that '*the application was easy to understand and use*' (md = 4).

Errors

The quality category concerning errors focussed on the number of errors participants made and which type of errors were made when using PODD. It was also important to evaluate the participants' experiences of being able to recover from the errors. Very few participants '*needed technical support to get started*' (md = 1) and only a few participants '*experienced that they made mistakes*' (md = 2). Comments in the free text space referred to errors made prior to being aware that they could magnify the text. Participants also mentioned that '*It was difficult to add an activity after recognizing it was missing*', while another, who also experienced errors, said on the other hand '*it was easy to correct mistakes in the calendar view*'

Satisfaction

Finally, the result from the quality component for detecting satisfaction in using PODD showed that the application was '*easy to use, not complicated at all*' (md = 4), participants experienced 'a *sense of control when using PODD*', (md = 4) and a majority of the participants agreed that it was '*useful to see the PDO in the calendar function*' (md = 5). Most participants also agreed '*that most individuals (with or without disabilities) can certainly learn to use the application*' (md = 4).

Comments in the free text space were, for example, '*Interesting to view and reflect on PDO*', '*The PODD is easy to use and easy to bring*' and '*Good visual overview of daily activities*'

Discussion

The purpose of this study was to test the usability of the PODD application as a tool for diary data collection in order to detect and visualize activities in the unique sequence of activities of the individual diarist, which is the basis of his or her PDO. This was a first phase of usability testing of the PODD and the sample of participants was purposefully selected for the study. The participants generally found the PODD smartphone application easy to use and perceived it to be useful. Moreover, almost all participants perceived it useful to see their PDO in the calendar function. The participants also reported that their impression was that most people (independent of functional capacity) could certainly learn to use this smartphone application. Participants also reported a high level of confidence when using the application. The result indicates that PODD may be a useful tool for diary data collection for people who are motivated to change their everyday life routines. There are however a multitude of further challenges in order to develop the PODD to be useful in other groups of individuals that are having limitations that were not represented in the current sample of university students.

The use of electronic devices to support client's autonomy and adherence in health care is a developing field. The Swedish Government and the Swedish Association of Local Authorities and Regions presented in 2016 [28] a vision to increase and develop the use of digital opportunities. This included the aim of developing and strengthening clients' own resources for greater autonomy and involvement. In order to realize the aims set out in the vision the importance of digital use that comprises high quality and supports the development of digital devices, has been highlighted [28]. The analyses of an individual's daily life, in terms of activities performed in various geographical and social contexts and in which the diarist's different projects are embedded, entails data with specific qualities, of which maintaining the activity sequence is of the greatest importance. This is visualized in the PODD.

The PODD is based on the principles of time geography, where the most important one is the indivisibility of the individual [8], which implies an unbroken activity sequence of the day. The development of PODD is based on the needs for a methodology that enables clinicians, researchers and maybe foremost the diarists to detect PDO in real-time, in PODD this is shown by the activity, geographical and social context. In addition, there is a need for a diary method that demands little extra effort for the diarist to carry and complete. To the authors' knowledge, this is the first study to test the usability of an

application that provides a method for both detecting and visualizing PDOs at an individual level where the activity sequence is maintained. Additionally, the individual PODD-based diary results can be processed and presented at an aggregate level without losing the characteristics of the individuals. Most electronic diaries enable full automation of data processing, thus saving time and costs, especially for the professionals in clinical settings in comparison with the previously used paper-and-pen, hand-written data collections. Approximately 50–60% of the data collection costs can be saved when using electronic applications instead of paper-based instruments [29].

Vrotsou et al. [16] created the PODD for electronic collection of diaries, based on the time-geographic diary method and its activity categories. This digital device captures activities as they are sequentially performed and the diarist does not need to consider time as it is automatically recorded. Information concerning the activity performed, secondary activity, place, companionship, emotions and other important things, which are asked for depending on the purpose of the intervention, are logged by the diarist.

The diarist can recognize his/her PDO developing during the course of the day as the activities, places and social contacts are filled in, and at the end of the day, the data are sent to a server. The occupational therapist then receives the data and can visualize the activity sequence both as a graph and as time spent on activities of various categories. This is useful for further analyses together with the client. The time-geographic diary method as manifested in PODD is then used as a tool to visualize the sequence of activities in their geographical and social contexts, in order to detect and reflect upon what is needed to overcome and possibly be changed in a PDO. The diarists themselves produce the data and they control the input procedure. Self-report electronic instruments are increasing in use in healthcare settings [30], while enabling high quality and autonomy for the user [31] and acceptable psychometric properties [32]. The individuals' experience of control of the input of data is believed to be important when using mobile applications and impacts the likelihood of future use [33]. The diarist is by her or himself in charge of filling in data that creates the visualization of their daily life. The visualized activities in a PDO, which the diarists have themselves made and can recognize, can become a powerful start for a discussion about the individual's unique daily lives and in turn a basis for further goal setting and intervention.

The results from the usability testing revealed that the participants agreed that they were able to learn quickly how to use the PODD application. They experienced a high level of confidence using it since it was easy to use and only a few participants experienced that they made mistakes. It is promising in the light of further development of the device that the participants experienced the application as sufficiently easy to navigate and the high rating for the usefulness of seeing their PDO during the course of the day. Little time was needed to record additional context information such as companionship, place and experience when performing the activity. Furthermore, PODD includes the opportunity to report simultaneously performed activities. Participants often reported that they performed more than one activity simultaneously. Interestingly, some students reported a need for logging several simultaneously performed activities.

We invited students in this usability study to voluntarily download the time-geographic diary application, PODD, to use it and to give us feedback in a questionnaire. In future studies we need to test the application with people who are in need of changing their PDO as well individuals with physical disabilities or cognitive limitations who may have challenges when using new digital tools. The latter is to investigate whether the interruptions caused by merely using the PODD application device challenges individuals who are already under stress and experiencing limitations in everyday life. Similarly, it is important to explore to what extent PODD interferes with the daily occupations among individuals who are not able to deal with a new digital device easily. The use of digital health applications is growing among young adults and adults of all ages [29]. Nevertheless, a recent study show that larger proportions of individuals with disabilities are digitally excluded than is the Swedish population in general [34] The development of smartphone applications should thus be designed for the level of perceived ease of use and ensure usability also for persons with disabilities [33].

It is, however, difficult not to interfere or add an extra activity in the PDO when collecting diary data. Using an application on a smartphone was assumed in this study to be easier than carrying a notebook and pen. However, the need to stop/pause the doing in order to log data might have interrupted the diarist, which is in fact a problem that all diary methods have in common. Another problem common to all diary methods, is that it can be assumed that even if the aim was to log all activities, some activities may have not been logged.

Limitations and further development

Some shortcomings should be acknowledged regarding the methodology of the study. We tested the usefulness of the PODD mobile application in terms of its usability [22] (how easy is it to use) and utility (does it visualize what diarist and researcher/therapist need to see).

The sample was limited even if studies by Nielsen and Landauer [35] indicate that only five users are enough to uncover 80% of usability problems. The actual number of users required depends on the complexity of the given application. Other usability evaluations show that 15 participants are able to uncover usability problems [36]. The ideal number of users in usability testing has not yet been determined and further research is required. It is important to develop greater knowledge in this field since the use of internet for web-based data collection is increasing in the evolution towards eHealth [28].

Only 20 students of the 31students, who completed the PODD diaries in this study, also answered the questionnaire. There is no indication that this smaller number of students should be interpreted as constituting an initial resistance towards detecting one's daily life in PODD. However, even if the targeted group of students can be assumed to be interested in detecting PDOs, few students (31 students from 94 eligible) from each semester chose to participate in the study. Students were not given any rewards for participating in the study.

The questionnaire, which was developed specifically for this study, were inspired by the System Usability Scale, a standardized psychometric tested instrument [22]. However, for this study several questions and statements were added. The statements were believed to capture aspects of the definition of usability [20]. A symmetric five-point Likert -type scale was applied to each item where the participants could choose from two disagree-alternatives (1 and 2), one neutral (3) and two agree-alternatives (4 and 5). The scale was thus open for neutral answers as well as some variation in the extent to which the participant agreed or disagreed. The scale was used as a Likert type scale in this study [24] and each statement was analysed as a single item and no sum of the rated statements was calculated. The recommended measure of central tendency and dispersion for ordinal data is the median [24]. However, Ankur et al. [24] have stated that using the mean as a measure of central tendency with Likert-type scale data is acceptable. The reason for quantifying the user experience and taking the mean of ordinal data as well as interval data is to derive meaning for each single item and to highlight the users' rating of experiences when using the PODD. The mean and standard deviation have the advantage of revealing differences in smaller sample sizes, such as in this study.

The PODD application needs to be further evaluated in other contexts and among other groups in order to get a broader picture of its usability. Furthermore, for clinical settings, a development focussing on strategies for transferring and storing client data is of great need in order to guarantee data protection and client security [37]. It is however, of great importance for individuals who need to make changes in their PDO, to be able to be aware and reflect upon sequences in their 'doings'. This is an example of a situation when occupational therapists may use a device, which is easy to use and is safe and inexpensive, to help clients to mirror their own doings. The PODD as evaluated in this first phase pilot, appears to be relevant for further development. Since this study was performed on students it is, however, important to broaden the study sample and to evaluate the tool in clinical settings.

Conclusions

After the first round of usability testing in a cohort of students, PODD has shown to have potential as a means to register and visualize sequences of daily activities and corresponding locations and socialization. We configured and tested the diary data collection application (PODD) based on the time-geographic approach, for use on a smartphone or a tablet. The PODD, in comparison to most smartphone applications, also provides knowledge about the activity sequence of the unique individual. This is important for the diarist's opportunities to identify his or her PDO with the purpose to make improvements therein. Using the PODD mobile application to collect diary data as tested in this study is promising, however, it needs to be further evaluated among other groups relevant for the tool's purpose.

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The authors report no conflicts of interest. All authors are responsible for the content and writing of the paper.

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