The ONS Online Time Use Survey:

Creating a Feasible Platform for 21st Century Time Use Data Collection

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1. Introduction

This paper discusses the feasibility of creating a representative and cost-effective time-use survey which is hosted online for ease of use as well as ease of data collection. In designing, developing and utilising the survey, the ONS has overcome substantial challenges to achieve ambitious targets for the Online Time Use Survey (OTUS). Overall, the online platform has been successful in collecting data, and this positively impacted the dissemination of results which went on to benefit various UK government departments as well as society. While the pilot was a success, there are ongoing improvements required for the OTUS to achieve its initial aims in their entirety.

The paper begins by providing a background to the OTUS, both in terms of academic context and the original aims of the project. Section 2 gives an overview of the current iteration of the tool, describing the diary tool itself as well as the demographic questionnaire that accompanies it, and the method of data collection regarding the selection of respondents. Section 3 considers the myriad of changes made to the OTUS since its inception, explaining why developments took place across all three waves and whether they resulted in an improvement in data quality. This section also explores early considerations relating to seasonality, accessibility and finding a way to meet policy needs. Section 4 focusses on the strategy of collection, outlining decisions taken to improve the quality of survey results. This included adjusting monetary incentives given to respondents, whether to issue the surveys once or twice in a collection period, the best way to elicit accurate responses regarding time spent on passive care, and exploring in-depth measurements for paid work activities, which were particularly relevant to the changing behaviours associated with severe acute respiratory syndrome coronavirus 2 (henceforth Covid-19) such as working from home and gig or sharing economies. Section 5 discusses the results of the OTUS, both in terms of improving the data quality and the information disseminated from the three waves of the survey. This is discussed through the increases in response rates by demographic, in line with the aim to make the OTUS as representative as possible, as well as by highlighting the successful publication of articles on topics ranging from the gender gap in unpaid work to potential changes in behaviour after receiving a Covid-19 vaccine. All publications were received positively by government departments, the wider public, and media organisations. Finally, section 6 describes future work and changes to the OTUS in the expectation of future waves of the survey (dependent on funding and policy demand). This work is divided into short term changes to the diary tool, such as updates to reflect the use of devices when exercising, and long-term considerations such as automating parts of the survey based on previous responses, or potentially using GPS data for recording travel and location. The paper then concludes with a review of how successfully the OTUS met its original targets, which are outlined in more detail below.

Background to the Online Time Use Survey

The OTUS (Online Time Use Survey) has been designed in response to decades of research and high-profile international reviews assessing the limitations of economic statistics in measuring a country's economic growth. For example, the report by Stiglitz, Sen and Fitoussi (2009) and the Independent Review of Economic Statistics in the UK (Bean, 2016) suggested shifting measurement systems away from economic production (for example, GDP) and towards measuring people's wellbeing instead. Crucially, they also recommended a larger focus on the household experience of economic well-being, and to consider a more complete picture of work that includes unpaid work. The reviews also sparked multiple studies, including a consideration of inequality and distributional analysis (Piketty, Saez and Zucman, 2017), economic well-being indexes (Jones and Klenow, 2016) and subjective well-being (Easterlin, 2015).

The OTUS was proposed as a preferred means of measuring productivity, not only did it reframe productivity away from traditional economic production values, unlike GDP, it had the potential to measure a range of unpaid work. This included everything from looking after children and doing house chores to using digital platforms to organise holidays (as opposed to using travel agents). The diary format of the survey also made it harder for respondents to misrepresent themselves. For example, Juster and Stafford (1991) demonstrated that diary instruments limited recall error and provided more accurate time measures.

Whilst time use diaries had been used previously in varying international contexts, the OTUS pilot was unique in its effort to carry out a cost-effective online version for the UK. Previously, time-use surveys have been expensive and time consuming to run as they required respondents to fill out paper diaries that were burdensome and needed extensive manual coding after collection, as well as regular calls from field interviewers to ensure data was being recorded correctly. This was the case for the UK's 2014/15 time use survey, which was used as a foundation for creating the newer, lighter online version rolled out in 2020 alongside the 2005 omnibus which focused on a pre-selected set of activities.

To achieve this, developments began in 2017 and carried through to 2021 as the ONS set out to achieve an ambitious set of targets relating to the new survey. First, to test if it was possible to measure time-use online in a representative and cost-effective manner. Second, to track the real-time changes occurring in an unprecedented period of behavioural change due to Covid-19. Third, understand the extent of unpaid work in the economy and its distribution between demographic groups (for example, the gender gap). Fourth, gauge whether time-use could be useful for more complete measures of paid work by incorporating aspects of gig-economy (for example delivery or taxi services such as Deliveroo and Uber) and sharing economy (for example online markets such as Ebay and Airbnb). Fifth, understand the feasibility of collecting information on device use and related measures such as screen-time, as well as how digital service provision is changing people's habits and who is benefitting from them. Overall, the aim of the OTUS was to gain a complete record of economic activity while capturing the household perspective of life as closely as possible.

The survey was not originally designed with the coronavirus outbreak in mind but happened to be well-placed in capturing experimental results linked to the pandemic. Firstly, the data could quantify the scale of changes in behaviour in key areas such as home working, home schooling, travelling, exercising or socialising. The results could be compared with the last UK time use survey taken in 2014/15 (in a paper diary format), using the latter as a marker for what normality looked like before

the pandemic. Secondly, it offered the ability to map activity to time across the day to understand how working patterns were arranged around other informal commitments (such as childcare) or leisure time activities using 'tempogram' data visualisation. Finally, the time use study also collected data about respondents' enjoyment of time and aspects of quality of life which helped determine how respondents felt about the activities that pre-occupied their time. This enables researchers to investigate issues of the relationships between finances, time-use, well-being and welfare. To our knowledge, the OTUS is one of the only representative time use surveys to be carried out during the pandemic and hence has much value for researchers from all disciplines.

2. Overview of the latest iteration of OTUS

The OTUS consists of an online diary tool and a demographic questionnaire. The diary tool is filled out online, and respondents are asked to fill out a diary for one weekday and one weekend day. In essence, the diary tool records over 70 different activities people spend time on, as well as other measurements such as their enjoyment, device use, partial location, and wider caring responsibilities. The demographic questionnaire is completed at any time alongside the diary tool, and records data about the respondents such as sex, ethnicity and age. The overview of OTUS laid out below refers to the survey in its current iteration as of August 2021. It was designed in this format to measure time-use in a representative, comparatively cost-effective way, while tracking real changes to how people spend their time, in light of ongoing lifestyle changes relating to the UK's response to the Covid-19 pandemic. There were several iterations of this survey before this point, all of which informed the development of the latest version. For information on how the OTUS developed up to this point and the approach to iterative improvement, see section 3.

2.1 Timeline of OTUS waves

Three waves of data were collected from the first iteration of the OTUS in 2020, to its current form in 2021. In the initial contract with the collection agency, it was agreed that two waves of data would be collected, with an option to utilise a third (which was also collected). Since wave 3, the ONS are investigating into the possibility of future waves and more regular time-use collection, dependant on funding and relevant policy needs. The dates for each wave of surveys were as follows:

Wave 1: 28th March to 26th April 2020

Wave 2: 5th September to 11th October 2020

Wave 3: 20th to 28th March 2021

These periods were particularly helpful in terms of measuring people's behaviour at key stages of the Covid-19 pandemic in the UK. In wave 1, respondents were experiencing the first nation-wide lockdown in response to the pandemic, with government restrictions severely limiting all but necessary travel or contact with other households from the 26th of March 2020. In wave 2, these restrictions had mostly been lifted, and the collection was timed to coincide with the majority of schoolchildren returning to schools. However, there were distinctions between government rules in

England, Scotland and Wales, and so changes in behaviour in these regions could be compared using the survey. By wave 3, vaccines for Covid-19 were being rolled out across the UK, with approximately 30 million people having received the vaccine at the time of the survey (Vaccinations in United Kingdom, 2021). Furthermore, March 2021 was a rough marker for one year living in a pandemic, providing the possibility to compare directly with wave 1 to see how individuals had faired one year on. A proportion of respondents were also able to be longitudinally linked between wave 1 and wave 3, allowing for a more direct comparison, different forms of analysis and further testing of the improvement of the tool. Results for each of these waves can be found in section 5.

2.2 How respondents completed the OTUS

First, respondents logged into the online diary tool with their username and password. At the homepage of the diary (Fig. 1) they could choose to fill in their demographic questionnaire or first complete their diary entry for the day. The questionnaire on the left of the homepage had a range of standard demographic questions covering areas such as age, sex, religion and work status. The priority here was to gather data on protected characteristics, which are demographic characteristics that cannot be discriminated against in UK law, in order to link to the SDGs (Sustainable Development Goals) by measuring time-use across as many vulnerable demographics as possible, and therefore providing data on inequalities. The demographic questionnaire also measured people's subjective well-being, such as their happiness, life satisfaction and anxiety, with the aim for this to link up subjective feelings with objective experiences recorded in the diary. This has the potential to provide an alternate measure to the more established GDP treatment as welfare.

Fig. 1: The online diary homepage

Source: Office for National Statistics - OTUS

The diary tool on the right of the homepage presented two pre-selected days to be filled in by the respondent (one weekday and one weekend day). A countdown would start at 4am on assigned days, displaying the time left for respondents to complete the survey. Up to 72 hours would be allocated to finish or edit each diary day to encourage accurate recollections. The countdown was developed for wave 3 due to feedback that respondents were unclear as to whether they had fully submitted their diary days and would get their incentives or not.

Once inside the diary tool, respondents had access to the following pages, which they could navigate through step-by-step:

1. Instructions and guidelines
2. List of activities
3. Timeline for recording main activities
4. Timeline for recording secondary activities
5. Final questions
6. Diary review and submission

In the first two waves, there was a further timeline for allocating any other device use, on top of other activities which had already been identified as using devices in main or secondary activities. However, it was found that there was minimal device use being captured uniquely within this page, and there was a lot of overlap. See section 3 on developments and user feedback that informed this.

The diary day started and ended at 4am, and respondents were asked to fill the entire 24-hour period with activities, leaving no gaps. To achieve this, respondents first recorded their main activities lasting 10 minutes or longer, which were their main focus at that moment. Once completed, they recorded secondary activities which lasted 5 minutes or more, representing activities that were done in the background or involved multitasking. For example, watching TV (main activity) while drinking a cup of tea (secondary activity) and checking social media (secondary activity). The OTUS distinguished between main and secondary activities to capture a fuller range of possible time use. The treatment and description of what constitutes a main activity and what constitutes a secondary activity was clarified across the waves in the associated documentation.

Fig. 2: Timeline for recording main activities
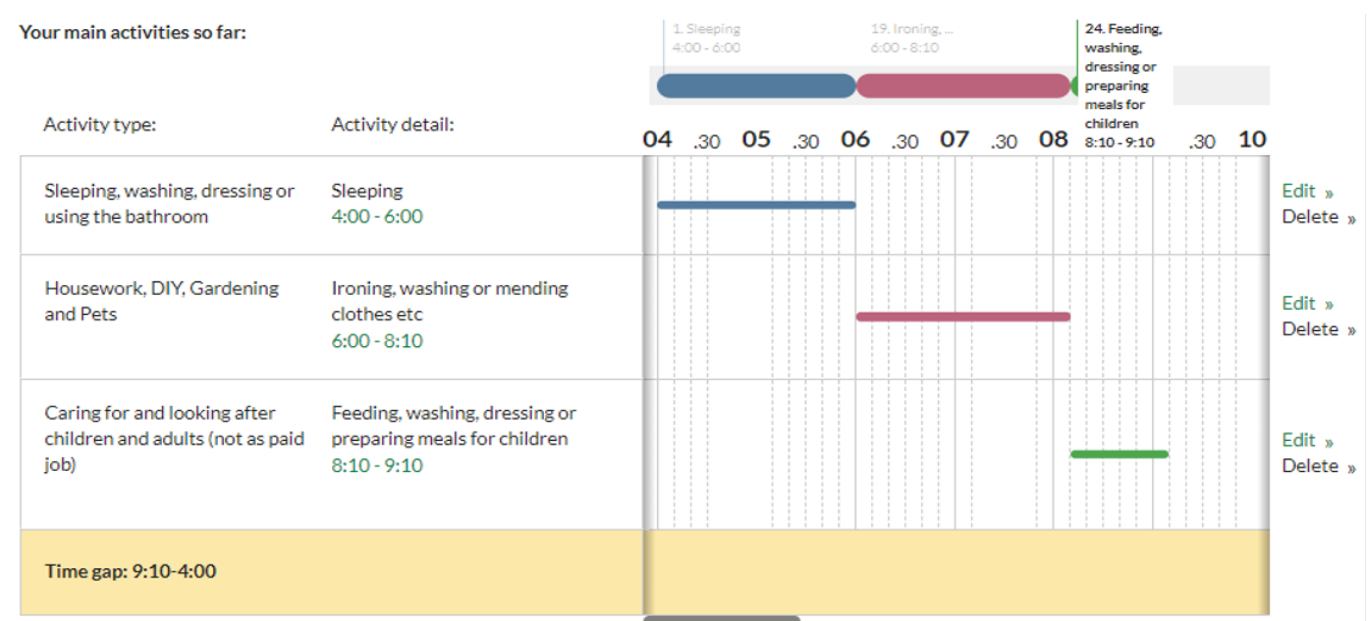
Activity (Thursday 5 December 2019)	From	Duration (hours)	Duration (minutes)	
Find or type your activity	16:10 ▼	0 ▼	0 ▼	**Add activity**

Source: Office for National Statistics - OTUS

As the respondents added activities to their diary timeline, additional pop-up questions would appear depending on the activity selected. For each activity, respondents recorded how much they enjoy each activity, apart from sleeping where it was reformulated based on user feedback. See section 3 on developments below. Once all questions were complete, the activity was added to the timeline. Below is an example of the pop-up questions when the activity "Travel or transport" was selected:

How much did you enjoy this activity? (Scale from 1 to 7, or choose "Not applicable")

Why did you travel? (Select option)

Commuting

Business (e.g., work, conference)

Education

Escorting for education

Escorting (other than education)

Personal business (e.g., medical, eating alone, other)

Visiting friends or family at a private home

Socialising with friends or family elsewhere

Entertainment or public event

Participating in sport

Going to or from a holiday in the UK

Going to or from a holiday abroad

Day trip

Other

How did you travel? (Select option)

Walk
Bicycle
Car or van driver
Car or van passenger
Bus or Coach
Rail or Underground
Taxi or minicab
Other public transport

Other private transport

Fig. 3: Timeline for recording secondary activities

Source: Office for National Statistics - OTUS

Respondents could move on to add secondary activities using the same format. Secondary activities could only be filled in at times when main activities had already been added, so respondents benefited from filling in all their main activities first. These were shown in a narrower timeline at the top to help recall. Up to five secondary activities could be selected to occur simultaneously. There was a handful of respondents who wanted the functionality for more than five concurrent secondary activities.

The survey was designed to have fewer pop-up questions for secondary activities in order to lighten the burden on respondents. For example, there were no enjoyment scale questions, and pop-ups mainly appeared in areas specific to caring activities and device use, which have both been identified as priorities for further research into time use.

After completing both timelines, the respondents moved on to the "Final questions" page. This section was separate to the 24-hour format diary and asked whether they were responsible for another child or adult on their assigned diary day. The question was designed to capture the total time spent on

care activities (both passive and active) during the entire 24-hour period. This was to better understand the time that caring responsibilities take, and to include passive care work, such as being responsible for a sleeping baby, which may not have been captured by the diary tool. More information is provided into the improvement of this in section 4 on strategy below.

Finally, due to Covid-19, a specific question was added to give a frame of reference to the respondents' activities, asking "On your diary day were you self-isolating due to Covid-19?". This could help to explain results around people's socialising as well as compliance, or potentially be used for separate studies related to behavioural research. Once the final questions were completed, the respondents reviewed and submitted their survey.

Fig. 4: Final questions

Source: Office for National Statistics - OTUS

2.3 How data was collected

The first step in collecting the data was obtaining a representative sample of Great Britain. The sample for this survey was a probability-based panel study of adults aged 18 and over, recruited via a collection agency. This was a random probability panel of respondents invited to take follow-up surveys after completing the British and Scottish Attitudes Surveys. One person was selected to respond from each household.

The sample of respondents was divided into two groups, with one receiving telephone support for the survey. The majority (85%) of the sample were contacted and engaged with exclusively via post, text message and online communications. This group logged into the online diary themselves to complete the diary information with minimal training beforehand, other than the guidance issued to them in the paperwork sent. The remaining 15% of the sample were predicted by the collection agency to have a preference to respond via the telephone interview unit, using a regression model using their known

characteristics and their previous preferences to make this judgement. The use of a probability-based panel was a cost-effective solution to an otherwise expensive field work exercise.

After a representative sample was determined, collection would occur. Following an agreement to participate in the study, the sample would be sent an email containing a link to the diary tool, their two assigned days for the study period, and their username and password. This information would be sent two days before their assigned diary day, with a reminder being sent on the morning of their assigned day. The respondent would then log in and fill out the diary tool according to the activities they had undertaken (see section 2.2). If a respondent does not fill out their diary on the day, an email and text reminder would be sent the day after. The amount and detail of reminders was adjusted across the waves, as it was found that it would be more cost-effective to only remind once a day, with minimal impact on response rate. Respondents would also be required to fill out the demographic questionnaire. In the first wave, the respondents were presented with the demographic questionnaire first before accessing the diary tool, while in subsequent waves they could fill the questionnaire out at any point by accessing it from the home page.

For those responding over the telephone, they would be assigned a telephone slot to be reached after each diary day is over, and the telephone interviewer unit would use the same online tool as if they were the respondent. No specific platform was designed for the interviewers, and this may be optimised in future collection if still outsourced, as well as to be able to integrate with the collection agency's administrative systems. If respondents were not initially reached, a new call slot would be assigned to telephone interviewers within the 72-hour time limit.

For those who did not complete both diary days, no days were re-issued in wave 3, to test the relative quality of the survey from first issues only, as well as to test the viability to collect and disseminate survey results in a timelier fashion. However, in the first two waves, respondents would be reassigned another survey day (weekday, weekend day or both if no days were completed) a few weeks into the future, with a few days' notice similar to first issue collection.

Once the collection period was over, the data could be extracted from the diary tool and demographic questionnaire in real-time, in several separate csv files. Respondents' time use, final questions including care and self-isolation, and demographics would be able to be linked via their unique panel ID and Date. Data would then be cleaned and manipulated into a usable format. The main quality check that was performed on the data was to ensure that the total duration recorded by respondents multiplied by the number of distinct episodes of activities was greater than or equal to 10,000. This ensured that respondents had recorded enough activity throughout the day that the data was usable.

Following quality assurance of the data, weighting was applied to obtain estimates that were representative of the GB population. Calibration weights using age, sex, region, tenure, employment, and ethnicity as calibration constraints were created. The calibration procedure ensured that the weighted sample totals on the constraint variables matched known population totals. For the individual level (demographic questionnaire) dataset, all cases were calibrated simultaneously in a single run. The diary tool dataset was split into a weekday and a weekend part which were each calibrated individually. After calibration, they were recombined by assigning the weekday data 5/7 and the weekend data 2/7 of the total weight. Separate non-response weights based on information from previous survey responses were also provided from the collection agency.

3. Development and iteration stages

The development of the OTUS tool included multiple considerations, including: the structure of the tool and feedback from users; results from user testing and quality assurance; edits to the tool based on feedback and policy needs; accessibility considerations for diverse user abilities; and the effect of seasonality on results. A key focus of the development of the tool, throughout the project, was to continually make user-driven improvements. This was to meet the original goal of testing the viability of a lower-cost online time-use survey, and to explore further improvements that could be applied for quality and impact purposes. These iterations took place throughout the pilot year, across all three waves, and further adjustments are expected in future waves, which will be discussed in section 6 on future work.

3.1 Developments before wave 1

The development of the OTUS tool began with an initial activity framework, where the design was informed by past research into time use. This then went into development from multiple rounds of user testing, before the pilot survey was rolled out for wave 1 in March and April 2020.

72 activities were listed in the tool for wave 1, along with a demographic questionnaire and follow-up questions. Activities were split into primary and secondary categories with an aim to capture multitasking and other activities that may not have been the full focus at a given time. Device use was also initially recorded on an additional page, to find out about screen time and wider device use that was separate from the activities listed.

Creating the diary tool structure

To create an effective diary tool structure, there was an initial exploration into how people naturally thought about recording their time, and how they categorised their activities. This ultimately informed the full activity framework that was to become the foundation of the diary tool. ONS outsourced user testing with a blank diary for respondents to fill out with free text and explored a sub-set of the original responses to the 2014/15 UK time use survey (which also used free text options), focusing particularly on the level of detail given to computer and digital-related activities.

For the user testing, respondents filled in a blank digital diary (table 1) and were then shown the free text activities they'd filled in, plus other responses, and were asked to categorise them. This mimicked the 2014/15 paper diary and allowed users to aggregate their activities themselves. This was to enable efficient level of detail to present to the survey respondents, as well as what activities were considered most similar.

Table 1: Example of free text diary format

Time	A) What were you doing? Please write down one main activity and only things which took longer than 10 mins	B) If you did something else at the same time, what else did you do? Only include things which took longer than 5 mins	C) Did you use a smart device such as a phone, tablet or laptop? Mark as 'Y' in time slots where you did	D) How much did you enjoy this time? 1 = not at all 7= very much
04:00-04:10	Sleeping			7
04:10-04:20				7
04:20-04:30				7
04:30-04:40				7
04:40-04:50				7
04:50-05:00	Got up and made breakfast		Y	1
05:00-05:10	Ate breakfast		Y	2
05:10-05:20	Got showered and dressed	Listened to the radio and had a cup of tea		3
05:20-05:30				3
05:30-05:40	Drove to work	Listened to the radio in the car		3
05:40-05:50		*End*		3
05:50-06:00	Started work	Had a cup of tea	Y	2
06:00-06:10		*End*	Y	2
06:10-06:20			Y	2
06:20-06:30			Y	1

Source: Office for National Statistics – OTUS

Various iterations were made to the activity framework both through this user testing and the wider rounds discussed below. To understand the breadth of changes to the activity list, wording and guidance, please see Annex A which compares the first version of the activity framework with the one used in wave 1.

In addition, qualitative analysis of computer-related activity was undertaken from 300 diaries of the 2014/15 time-use survey. This was to investigate the level of detail people considered when capturing this kind of activity without prompting – whether they distinguished between what device was being used, or the detail of the function being applied (e.g., emails, browsing the internet, using apps versus using the phone etc). This identified that, in general, people did not consider too much detail for such activities. The most common free-text phrases were related to emailing (for example, "checking emails" or "sending emails") and browsing the internet in general rather than specifying the device, or what websites were being browsed or for what reason. This resulted in these specific categories being identified in the OTUS activity framework, while also having a category for other computer activities not listed. Because an original focus of the pilot was to understand digital service provision, it was important to capture whether people's shopping habits were distinctly online as opposed to in a shop or shopping centre. Hence, the term used for shopping (which is the typical term people consider) asked a specific follow-up question on whether this was done face-to-face or online. Additionally, for household chores like banking, paying bills and GP visits, a question was asked on whether people used a device for that activity to see if they conducted it online.

User-testing, development and accessibility

On top of these activity-specific developments, ONS conducted several rounds of user testing. These ranged from short one-to-one sessions with a professional tester, to full runs of people completing their own allocated diary day with subsequent interviews with testers. This approach enabled

iterations of specific elements of the tool, such as the functionality to input an activity, the wording of instructions and other labels, functionality to export data, the home page, and the flow of data collection pages. Several rounds of testing resulted in essential feedback to improve the online diary tool further. For example, early summary findings suggested there was confusion over the meanings and interpretations of different activities, confusion over the difference between main and secondary activities, and the diary tool taking a long time to complete. These areas could then be targeted for improvements.

The first stages of testing identified that filling in the diary was particularly burdensome, overwhelming and quite frustrating. Suggestions implemented included being able to type an activity rather than simply select from a drop-down list, shrinking the number of secondary pop-up questions that were specific to activities, and functionality to more easily edit or delete activities.

Further stages of testing suggested improvements could be made to the instructions for the tool, how people capture secondary activities in a non-burdensome way, and how to identify and deal with gaps in time between main activities. Instructions were pared down and added to a separate webpage, so respondents could refer to them if needed while not being burdened with them. These continued to be improved and made more targeted throughout the waves, particularly on the clarification of what constitutes a main activity, as opposed to a secondary activity. Note, this terminology was not used much for respondents themselves as they did not understand it instinctively. A conscious choice was made that secondary activities tend to be more burdensome and previous time-use surveys conducted in the UK have also suffered from some of the coverage of these activities. Hence, no large changes were implemented prior to wave 1 to understand the number of secondary activities that would be recorded without further developments. Between wave 2 and 3, substantial changes were made, discussed lower down.

For dealing with gaps in time between main activities, several options were suggested from user testing. A requirement of the OTUS tool was to have people fill in at least 23 hours of time-use, which meant more targeted messaging was inserted if people tried to submit an incomplete day. Additionally, gaps were shown visually in the timeline (see screenshots in section 2) that explicitly referred to a gap in time, and how big the gap was. This was more for people who did not fill in their activities consecutively, as the time for new main activities was adjusted to start just after the last filled-in activity ended, so if someone was to fill in their day chronologically, they would encounter no main activity gaps.

This iterative approach also considered accessibility of the tool, to make sure people with different physical and mental abilities, and wider diverse needs such as the use of screen assistive technology, were still able to participate through an online survey. This is crucial for the ONS data collection strategy, which is to make sure all our outputs are representative of the population (ONS 2019).

A review was commissioned of the prototype tool prior to the build phase, to consider all elements of functionality against Web Content Accessibility Guidelines (WCAG) 2.1. ONS collaborated with the Digital Accessibility Centre who reviewed the initial tool and recommended improvements so that people who use a screen reader, have dyslexia or users who have cognitive impairments were better able to use the diary tool.

The Digital Accessibility Centre reported on the diary tool's ease of use, ease of understanding, accessibility challenges, areas which could be improved, and any instances of non-compliance regarding web content accessibility guidelines. Testing took place on desktop computers using assistive technology such as a screen reader (in various browsers) as well as tests on iPads and iPhones

using voice-over software. As a result of the review, multiple improvements were made, including timelines becoming keyboard-accessible and heading levels restructured to align with screen reader requirements.

For the diary tool, two crucial changes were strongly recommended to change, given how difficult it would be for certain groups of individuals to fill the diary in. The first was to remove the use of drag and drop functionality for the insertion of activity times and replace it with selecting time and duration from a drop-down menu. A screenshot below highlights how this functionality worked before the accessibility review, with the latest iteration shown in section 2 above.

Fig. 5: Screenshot of an early prototype of the diary tool before incorporating feedback from the Digital Accessibility Centre (circled numbers were points of feedback)
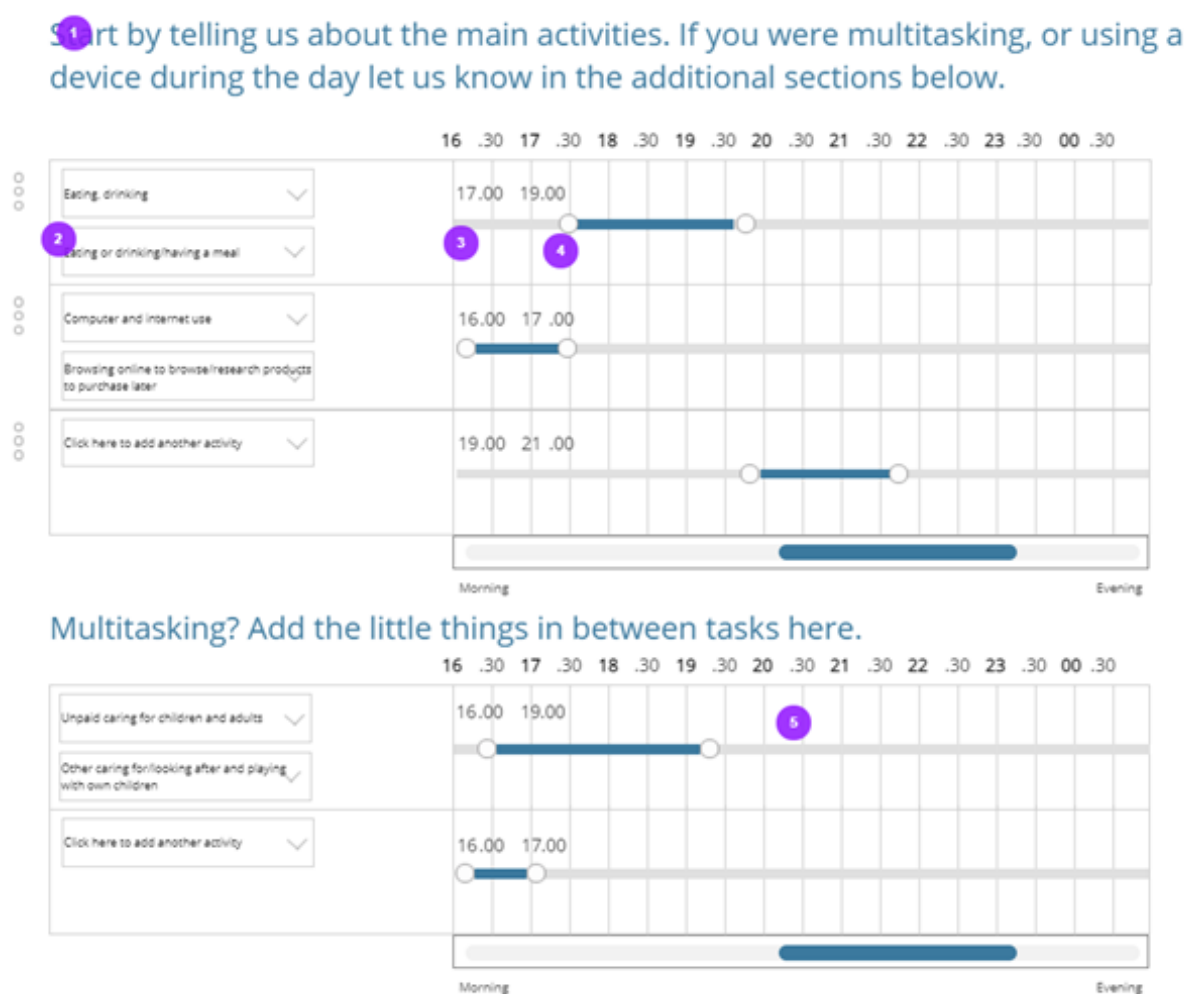
Source: Office for National Statistics – OTUS

As identified in points 3 and 4 (in the purple circles above), filling in time through drag and drop, and the activity times floating on the page would have been difficult for those who have motor problems and so may not be able to accurately select the start or end times with a mouse. The challenge would have been greater for those who instead of using a mouse use a keyboard. In addition, having the times as static text would have made it more difficult for a screen reader to identify them as being

related to a certain activity. In the screenshot above, point 2 would also have been difficult for a screen reader to identify which information was functionally and semantically related to other information, so the decision was taken to not show the high-level activity categories and simply present individuals with the full list of possible activities.

The other key difficulty identified was the cognitive overload in providing main and secondary activity inputs on the same page (point 5 in the picture above). This was recommended as potentially being too challenging for people such as those with learning disabilities, and the principle of respondents only focussing on one element of a question at a time was taken forward. As a result, secondary activities were instead shown on a separate page. These changes were critical in being able to progress with development of the tool, as it was essential that users of all aptitudes were able to fill in the diary.

3.2 Developments between waves

A core part of the OTUS pilot collection strategy was to use outputs from each wave to inform potential improvements for upcoming waves. Although the pandemic brought into focus the results in a much timelier manner (see section 5 on results) it was important to keep testing if certain aspects of the tool, associated documentation or survey design elements could be improved, or further insights gained on optimisation for better quality and representativeness of the survey. Strategic considerations before collection began are covered more in section 4, while here, more iterative changes are discussed.

After wave 1, feedback from telephone interviewers and analysis of results revealed areas for improvement, leading to slight changes to the survey before waves 2 and 3 were conducted. Minor changes were made to the wording of activities to make them clearer. For example, many respondents felt that splitting out washing up and cooking was not clear, and some felt that eating and cooking overlapped a lot, so the activity framework ordering was changed to help people find similar activities quicker. "Washing up" as an activity was modified to "Using a dishwasher or washing up" to reflect the other related unpaid work people undertake. Another example came from consistent feedback that people did not consider sleeping something they necessarily enjoy, and hence being asked about their enjoyment of it, particularly as it was the first activity most people would input into the diary, had a negative subsequent effect on the whole diary filling-in process. Hence, the enjoyment score pop-up question for "Sleeping" was rephrased to reflect the activity, reading, "How well did you sleep?". Finally, additional activities were added, including "Smoking or vaping", "Praying", and "Going for a walk as exercise", as something respondents particularly wanted to reflect, rather than putting in an "Other" category.

In addition, the passive care activities were moved outside of the diary tool to become an end-of-survey set of questions. This was to understand more clearly whether respondents were responsible for, or had supervisory care of, adults or children during their diary days. This is discussed more in section 4.

A further change between waves was the position and expected order of steps in which respondents took the survey. Analysis of drop-off rates showed the demographic questionnaire (taken before completing the diary in wave 1 as it was the first element of the survey presented) was responsible for a high proportion of respondents not completing the survey (see results in section 5). To remedy this, in wave 2 the demographic questionnaire did not have to be completed at the start to access the diary tool. Instead, it became an option on the homepage of OTUS, to be completed at some point

(before, during or after the diary) before submitting the final diary days. After analysing the larger drop-off in individuals filling in the demographic information, changes were made to the home page to make the demographic questionnaire more prominent (as can be seen in the overview of the tool in section 2) to make people logically consider it as needing completion before they finish the survey.

Finally, a change in strategy was implemented for capturing device use based on analysing the responses. In the testing for the lead-up to wave 1 a question asked whether people used a device for the activity selected, and this same question was asked for all activities where there was an interest in capturing such device use. However, this was clearly misunderstood for several categories (e.g., shopping, going to the cinema) where, in analysing results, the proportion of device use to face-to-face interaction was unrealistic given the pandemic conditions at the time of wave 1.

Feedback from telephone interviewers

Feedback from field interviewers was conducted at the end of each wave, giving more contextual qualitative information about the experience of filling in the diary, as the interviewer could probe and gain key insights as to where there could be gaps of activities not already covered. General feedback across the three waves was positive, with respondents keen to take part and chat about their day, relaying that it was a more interesting experience than a typical survey. Insights were given as to when respondents needed prompting for missing information. The type of activities that were often overlooked included unpacking shopping, taking a food delivery, or just going for walk, though it is important to note that generally respondents receiving a telephone interview were around retirement age or older. This group were encouraged to write down their activities to help with recall. This technique did help to capture most of their day; however, prompting was often needed for secondary activities such as watching TV or listening to music. In future, further improvements could be made to help the recall of secondary activities and identify such activities more quickly.

Table 2: Feedback raised by field interviewers in each wave

Collection element	Wave 1	Wave 2	Wave 3
Demographic questionnaire	Respondents requested the option to be able to skip questions on well-being	Retired respondents were confused as they were asked questions about their work/jobs due to a routing error	
Diary tool	Some respondents needed prompting for using the bathroom - and some the felt pop-up question on enjoyment could be reworded	No separate activity for "Using the toilet", they felt the available category "Washing, showering, getting ready, using the bathroom, etc" was too vague	No separate activity for "Using the toilet", they felt the available category "Washing, showering, getting ready, using the bathroom, etc" was too vague
	Secondary activities - respondents needed lots of prompting for things they were	No activity for "Taking tablets"	No activity for "Taking tablets"

doing alongside their main activity		
More clarification needed on the difference between a main and secondary activity	"Watching TV" vs "Streaming TV" - respondents needed more of an explanation	No option specifically saying "Travelling to the shops"
Respondents needed a little more detail for the work pop-up questions	"Talking with spouse, children or parents, family, friends or neighbours" and "Telephoning, texting, emailing or writing letters to friends and family" - respondents felt these activities overlapped	No option specifically saying "Travelling back home"
Respondents needed a lot of prompting for hobby related activities	"Washing-up" appears in two places – respondents unsure which to use	No activity for "Unpacking shopping" or "Receiving a food delivery"
	"Ironing, washing or mending clothes etc" – respondents felt this could include more i.e., hanging out clothes	Confusion on secondary activities, none given until probed
No activity for "Smoking"	Respondents felt the enjoyment question does not always apply i.e., if they've attended a funeral	
No activity for "Unpacking and putting away shopping"	Secondary activities missing – respondents needing prompting	
Sleeping – respondents did not think 'how much did you enjoy sleeping' made sense		
No activity for "Walking with no destination/purpose"		
No activity for "Listening to the news/radio"		

Source: Office for National Statistics - OTUS

3.3 Developments after wave 2

Following wave 2 of the survey, more substantial modifications were made, with the aim of reducing the respondent burden and meeting policy needs. This meant removing many of the pop-up questions, changing the paid work categories, changing transport categories and smaller edits to either include or edit activities.

Internal user testing

To further develop the diary tool an internal user testing project was launched prior to wave 3 development. This was particularly focused on lowering the respondent burden and any potential effects of bias in the representability of the sample. An advert went out across the organisation asking for ONS colleagues to volunteer to test the wave 2 diary tool and complete an online feedback survey. The experience was replicated as much as it could be compared with real survey respondents, given the circumstances of recruiting volunteers within the same organisation. Identical documentation was circulated, two survey days were allocated and they were given the same 72-hour deadline to complete each diary day. A positive 309 volunteers signed up, and each was allocated two diary days, one weekday and one weekend day to complete.

The feedback survey comprised of 51 questions covering all areas of the survey from information packs, logging activities, and submitting the diary days. A total of 258 diary days were completed, and 192 detailed feedback responses were collated. Qualitative and quantitative analysis showed respondents were able to understand and navigate through the questionnaire and diary tool, and successfully complete their day. Analysis also highlighted several areas of confusion and where small improvements could help reduce the burden to respondents.

Resulting changes

First, some activities and how they were categorised were edited. For example, the categories in the work pop-up question were adjusted after analysis of previous waves showed that a "select all that apply" approach could lead to vague results in some cases. This is further discussed in section 4. Additionally, changes were made to the reasons for transport categories, triggered by conversations with the Department for Transport to align with their travel surveys.

Second, many pop-up questions were removed to ease the respondent burden. For example, if a respondent were to select "Making food or drinks", they would no longer have to answer the follow-up questions, "Where were you?" and "Did you use a recipe?". These cuts were made in response to user feedback, which showed the survey took a long time to complete, representing more of a user burden than originally intended. Substantial time was taken up in completing secondary activities, so further pop-up questions were removed for activities when they were selected as secondary, while the equivalent main activities continued to have more pop-up questions on average. For example, no enjoyment questions were asked of secondary activities, to lower the burden on those smaller activities such as checking your phone for five minutes, having a cup of coffee, or doing a little bit of tidying. This had a very positive result, where the average number of secondary activities filled in per diary day actually increased, as can be seen in the figure below:

Fig. 6: More people recorded secondary activities in wave 3 compared to previous waves

NUMBER OF SECONDARY ACTIVITIES FOR THOSE WHO FILLED SOME IN

☐ wave 3   ☐ wave 2   ☐ wave 1
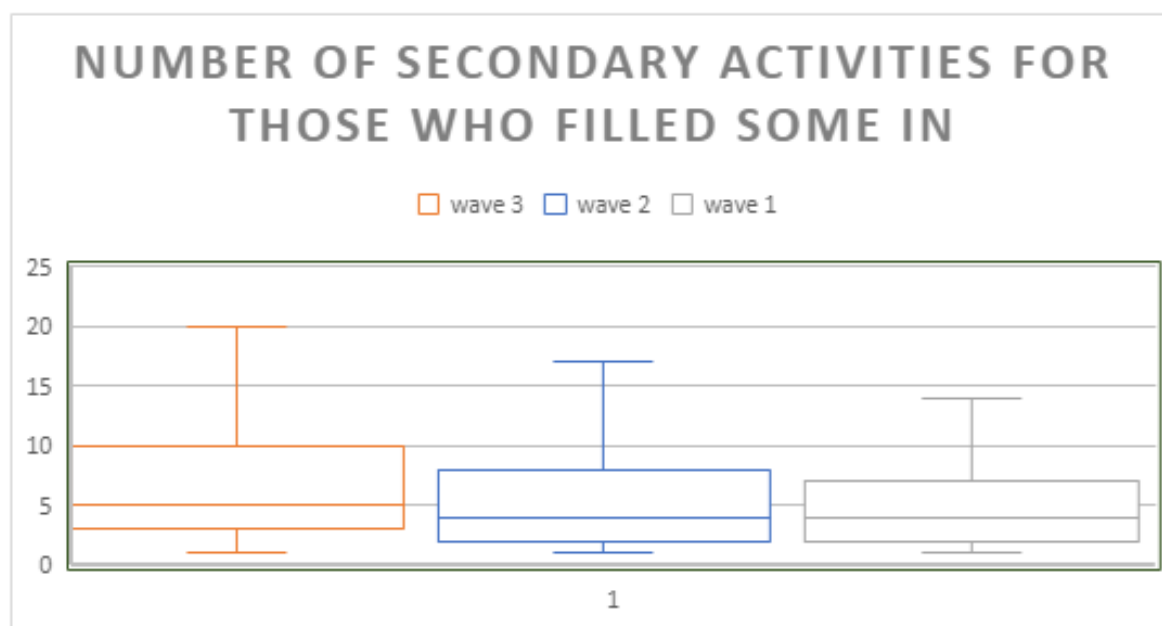
Source: Office for National Statistics - OTUS

In wave 3 the average number of secondary activities per diary day where there was at least one secondary activity captured, was 7.1, compared with 5.9 for wave 2. Additionally, the proportion of completed days with some secondary activities went from 66% to 75%, which is extremely reassuring. In fact, there were indications other changes also had beneficial impacts on quality and granularity on main activities, since the number of main activities per completed diary day went from 15.6 in wave 1, to 17.4 in wave 2 and up again to 18.8 in wave 3.

Finally, it was found that the device use page took a substantial amount of time, as people were repeating device use, they had captured in main and secondary activities, and people found it unclear. In addition, analysing the amount of unique time where device use was filled in in wave 2, when there was simultaneously no device use selected in main and secondary activities, identified very little activity. Hence, the decision was made to drop device use as a separate page for wave 3. This may have had a further positive effect on response rates (see section 5).

3.4 Ongoing policy considerations

The survey was also modified to respond to policy needs. Communications with government departments were originally intended to help the survey reflect wider parts of the economy, and core measures of time-use such as unpaid (and in measurement terms, unmonetized) work and productivity. However, with the onset of Covid-19, this soon changed to responding to specific policy needs relating to the pandemic. An advantage of having a flexible online pilot meant the tool could be modified quickly to respond to some of these needs.

For example, after Covid-19 vaccines had begun to be rolled out at the end of 2020, the demographic questionnaire was adjusted to include questions on whether respondents had received a vaccination.

The results were then used in a timely analysis investigating whether vaccines influenced how people spent their time.

Another example is the addition of a furlough question in the demographic questionnaire after a significant proportion of the UK population were placed on furlough. As well as this, a question was added relating to Covid-19's effect on employment. For example, respondents were asked whether they worked more or less hours than usual, and if these changes were due to Covid-19 with furlough being one of those options. These changes were informed by the economic climate in the UK, with the aim of responding to evolving policy needs.

In terms of activities, home-schooling was inserted as a specific activity that parents would undertake while schools were closed due to government restrictions relating to Covid-19. In addition, questions were asked at the end of a diary day around whether people were self-isolating or shielding from Covid-19 either because they were vulnerable, were identified as a close contact of someone who had tested positive for the virus, or due to them having had the virus, or waiting for the result of a Covid-19 test.

These aspects will be particularly useful in future analysis of UK behaviour, and behaviour of individuals in a pandemic setting, as researchers will be able to identify key groups of individuals and how their behaviour was influenced. The extra benefit of them being in a follow-up panel leaves open the opportunity to track how the behaviour of individuals across the pandemic evolves as the UK and the rest of the world recovers from the pandemic in coming years.

Furthermore, the period of collection was also considered, particularly for waves 2 and 3, with respect to changing government restrictions. Both were chosen to coincide with periods when schools were open to most schoolchildren. In wave 2 a lot more aspects of society and the economy were open, while in wave 3 government-mandated limitations on people's interactions meant most workplaces and social venues were closed in strict lockdown. There was also the opportunity to assess the effects of schools being closed along with the rest of society during wave 1, when the first UK lockdown was announced. To make such comparisons more meaningful, while also testing future collection opportunities for time-use, all people sampled for wave 1 (whether they responded or not) were also sampled again in wave 3, apart from those who had dropped out of the panel in the meantime, to consider longitudinal time-use data collection and analysis. Some of the results of such work are presented in section 5.

More recent feedback from UK policy users has focused on trying to capture children's time-use activity, which also feeds into OECD's recent strategy for children's well-being data (OECD 2021). This will be considered as part of future work.

3.5 Seasonality research

The effect of seasonality on results was an early consideration in the development of the study, and research was conducted into its effects before the first iteration of OTUS was completed in 2019. Research was undertaken by a central analytical volunteer team within the ONS, using various national and international surveys and time-use data from the 2014-15 survey. They found that whilst there were small, statistically significant changes relating to seasonality, the relationship was very weak, and therefore no seasonal adjustments would be needed. With appropriate considerations, picking specific times of the year could still give representative results for the year as a whole.

Fig. 7: Time spent on unpaid work activities by season
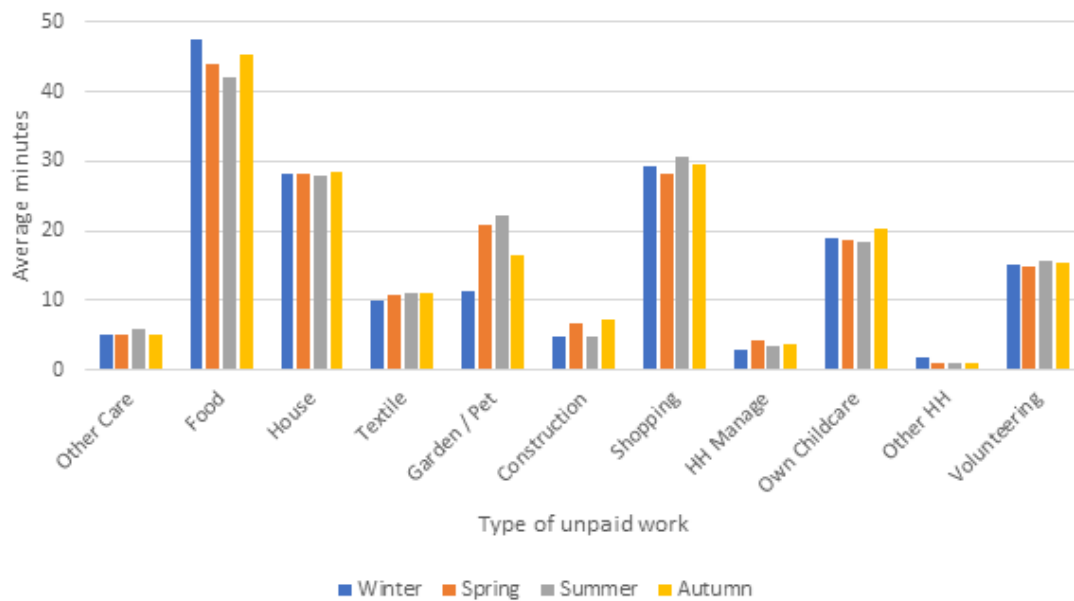
Source: Office for National Statistics - Central Analytical Team

This was considered before the drastic weekly, monthly and seasonal changes in behaviour came about from the pandemic. It is questionable whether having an annual 2020 or 2021 time-use series would be too meaningful, given how much change there was across the year, and how this was differentially impacting different parts of the population.

4. Strategy of collection

Alongside the development of the tool and associated collection instrument information, various critical elements were considered as parameters of this modern data collection exercise, to be optimised for future regular collection. This included applying changes across the different waves, such as the optimisation of incentives and documentation, and testing the quality of only collecting first issues. In addition, the new tool allowed for the exploration of more experimental, complete measures of time-use with regards to passive care and working time. At the same time, ONS' initial strategy was flexible in responding to the on-going Covid-19 pandemic by adjusting the data collection process in two critical ways: flexible wave collection periods to respond to changing government regulations (as outlined in section 2.1) and how this impacted on people's time-use, and consideration of longitudinal time-use data to compare on-going pandemic conditions. Some of these key elements are discussed in turn below.

4.1 Quality considerations: Incentivisation

Having moved time-use collection away from paper diaries to a mixed-mode of online and telephone collection, different considerations were applied to appropriate incentives. As this was the first full UK pilot of online time-use collection there was little evidence on the levels of respondent burden to weigh up against incentive levels. The goal of the study was to develop cost-effective data collection, and of course online submission enabled opportunities for a smoother overall experience. At the same time, there may have been a different level of respondent burden in filling in the survey online compared with the telephone. However, given the sample design determined who would be allocated a telephone collection based on differences in response rates in the past, and demographic characteristics, an early decision was made to not consider differential incentives across modes. Additionally, a helpful challenge from the collection agency ensured incentivisation was related to the core aspects of the data collection, namely each diary day, even if respondents had not filled in the demographic questionnaire. The unique aspects of time-use collection meant that restrictions had to be applied for valid submissions, and these were given to respondents up front. These included:

- Setting a time-limit on when a diary day could be validly submitted due to known previous experience with recall drop-off, ultimately 72 hours after the diary day was chosen as valid.
- Not being able to fill in periods of the day that were in the future (say, filling in the whole day at the beginning of the day while it was still going on). This was to ensure people captured actual time-use rather than planned or projected schedules, which may not materialise as people's days evolve.
- Requiring 23 hours of main activity before being able to submit a diary day and for it to count as a full day.

Nonetheless, in the first wave particularly, a large proportion of respondents signalled they were not happy with the seemingly confusing criteria and either dropped out through the survey, dropped out of the panel for future collection, or both. In particular, several respondents were not clear as to whether they had 'formally' submitted their diary day even though they'd filled in 23 hours, and after 72 hours the system would show a message that their day was incomplete. Further changes for wave 3 made this more visually clear (see overview in section 2). Hence, the later phases of incentive testing had to also consider future survey willingness as a success criterion.

Furthermore, new considerations relating to the difference in mode lent themselves to new opportunities. Instant real-time tracking of which days had been submitted by which individuals, and whether they'd covered 23 hours in those days, allowed ONS and the collection agency to consider single day completion as a valid partial response from panellists. In addition, as each wave was sampled independently, and survey administration was wave-specific, it was simpler to apply and trial different incentives with specific waves, which a continuous annual collection would have made more challenging.

Hence, the considered strategy, trading off costs, quality and administrative challenges, was to get a baseline set of responses and quality metrics from the first wave with a £10 incentive, where one-day completion was awarded £5 though not explicit in the documentation for panellists. This could then be compared with data and response rates from the second wave, which was split at £10 and £20 (again with single-day completion payments). As outlined in section 3, multiple other changes to the instrumentation also occurred between waves, so the split in sample would allow ONS to consider the separate effects from both changes. For wave 3, with the further introduction of a longitudinal sample (see results below) a higher incentive was tested again in a split sample (£20 and £30) also interacting with wave 1 status. This meant analysis could in future be undertaken to compare response rates for those who'd already completed the potentially more burdensome experience of the first wave, with those who had chosen not to complete the first wave.

The impacts to incentivisation are still being investigated, but initial results summarised below imply there may be room for further response rate and quality improvements from higher incentives, subject to unit cost considerations. For example, in the table below, higher incentives do have a substantial positive effect on response rate, with a £20 incentive increasing likelihood of any diary days completed by 9 percentage points compared with £10, and a £30 incentive increasing this by a further 7 percentage points. This is for the same time period of collection and with the equivalent tool and documentation.

Table 3: Effect from higher incentive on completion of diary day

| | Wave 2 | | | | Wave 3 | |
	Full sample		Sub-sample from BSA respondents		Full sample - BSA only	
Incentive split provided	£10	£20	£10	£20	£20	£30
% of sample who completed any days	32%	40%	44%	53%	52%	59%

Source: Office for National Statistics – OTUS

Notes to table 3: BSA = British Social Attitudes survey used as a follow-up panel to OTUS

4.2 How to accurately measure time spent on passive care

For more holistic measures of economic well-being, and economic welfare, it is important to capture the totality of time spent on unpaid caring for children and adults (Miranda, 2011). Active care - time spent where care is the main focus or effort of someone's time - has been measured in traditional time-use surveys, traditionally splitting out the care of children and adults, given their differential activities and market equivalent values (ONS, 2016). However, as all parents, carers and caregivers know, the entirety of the time looking after others is not active, yet it still may impact them, such as in their stress and depression symptoms (e.g., Tabler and Geist, 2021)

Capturing this wider, 'passive' aspect of care is typically more challenging to do through time-use surveys (e.g., Hirst, 2002) The typical diary format may not lend itself to people capturing it as a main or secondary activity, as it refers to conditional time spent in the need of someone else. Other more reflective questions on total time spent caring for others, particularly adults, tend to have much larger estimates of adult care than active adult care from time-use surveys, such as comparing UK Family Resources Survey estimates with Time-Use estimates (e.g., ONS, 2018a, ONS, 2018b) Hence, there seems to be a substantial missing amount from traditional time-use collection.

To explore options for this measurement, the OTUS pilot tested and adjusted its collection approach across waves, based on user testing highlighted above, and feedback from the telephone interviewer unit. In the first wave, two additional activities in the activity framework were tested to see if people would select them alongside their other main and secondary activities. They identified passive childcare and adult care separately.

Table 4: How passive care was collected in wave 1

Activity	Notes for respondents
Time with child in your care (secondary activity)	This includes <u>all the time</u> that you have a child in your care (please record this time in your secondary activities only)
Time with an adult in your care (secondary activity)	This includes <u>all the time</u> that you have an adult (age 18 or over) in your care (please record this time in your secondary activities only)

Source: Office for National Statistics – OTUS

These were hardly used for both children's and adult care in wave 1 - only 5% of respondents recorded time they had a child in their care and 1% of respondents recording time they had an adult in their care. Given that 29% of respondents had children in the household under 18 years old, and 7% of the whole UK population were carers according to the Family Resources Survey, it is clear this method of capturing passive care needed improvement. The low share of adult carers may not be too surprising, given the context of the early stages of the pandemic forbade people to go out and see others apart from to help other adults outside of the household in quite an active sense (e.g., getting their shopping). However, it was a big indicator of unsuccessful interpretation for caregivers, given all children, apart from those of 'key workers'[1] we're not going to school and not really going out during the early stages of the pandemic. If successfully interpreted, a large part of caregivers' time, particularly for younger children, would have been captured as passive care.

Hence, large adjustments were made for the second pilot wave, where questions were designed to appear at the end of the diary day, to reflect on the day as a whole. These are shown below, with the associated guidance given to respondents:

Before submitting, can you also tell us if and how long were you responsible for another person (adult or child) on your assigned?

Please include time you spent keeping an eye out or being responsible for any children (e.g., parenting or babysitting a child).

Please also include time you spent helping, caring, being there for or keeping an eye out for another adult (e.g., helping a dependent disabled or elderly adult to get something done or improve their well-being).

Do not include personal time when they were in the care of others (e.g., time at school, in day care or in the care of a professional).

Check the boxes below the time fields if you weren't responsible for anyone else.

Respondents no longer had to consider at which specific times of the day they were responsible for another child or adult, but instead to sum the total time for the diary day assigned. Again, children's and adults' care were separately identified, though in hindsight the distinction between when care is for a young adult or older child was not specified. This time, respondents captured this information more readily.

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[1] Key workers (or critical workers) are those who work in sectors that were deemed crucial to continue working throughout the pandemic. For more information, see here.

Table 5: Response metrics, wave 2

	Percentage of respondents with adult or child in their care	Percentage of instances where caring time was greater than 1400 minutes
Children	25%	13%
Adults	8%	17%

Source: Office for National Statistics – OTUS

Though the rough sample sizes for shares of individuals carrying out care had closer matched what is expected, the distribution of responses was still potentially sub-optimal. Only 13% of instances of passive childcare were over 1400 minutes, which is almost a full day. This indicated people may still not have been interpreting the question correctly, or at least consistently between respondents. Telephone interviewer feedback confirmed the lack of coherence in how respondents considered allocating their times. However, it is worth noting the biased sample of telephone-interviewed respondents, tended to be older, meant less insights could be directly provided on the passive childcare elements. In the context of the pandemic, grandparents and other adults were allowed to look after and care for their grandchildren and other family members' children outside the household, but also schoolchildren had returned to their place of study for the new academic year in September 2020.

Hence, the internal ONS user testing conducted post-wave 2 explicitly asked individuals how they calculated the total time spent in passive care, for those who had selected it. This qualitative research provided lots of insight into the drawbacks of the format. The main issue was in whether to consider all the indirect time even when children (or adults) weren't in the same room, whether to count the time when the respondents themselves were sleeping or engaged in other focus altogether. Examples of responses from the internal user testing include: "Calculated the time he was at home until he went to bed", "I was in the same room, watching tv together - but not really 'supervising' so not recorded".

The guidance was modified but the format of questioning still left for the end of the diary day, and this was run for wave 3.

See section 2.2 How respondents completed OTUS for the final wave 3 passive care questions.

Table 6: Passive care response metrics, wave 3

	Percentage of respondents with adult or child in their care	Percentage of instances where caring time was greater than 1400 minutes
Children	25%	19%
Adults	6%	30%

Source: Office for National Statistics – OTUS

Results from wave 3 seem to show some improvements, with clearer understanding from telephone interviewers and hence the guidance provided to telephone-interviewed respondents. Metrics from the survey show that roughly the expected proportion of respondents are recording passive care, with the distribution of responses now being more in line with external source expectations.

Clearly, more work is needed to help respondents work this key measure of time out in a less burdensome way. For example, some of the feedback from the telephone interviewer team suggested providing an analogue clock to help people mentally sum up the time. Additionally, given the active care provided by these individuals has already been captured in the diary by the time this question is shown, perhaps this can be flashed to remind people of the active day slots (as well as pre-calculated the total time they spent in that type of care) which may help with recall. However, there is promise that this type of question can more fully capture the total time of both passive and active care provided.

4.3 Analysing valuable measurements for paid work

Critical to the nature of how people spend their time, with large impacts to subjective well-being (Angrave & Charlwood, 2015) as well as economic well-being (Rice,et al, 1980), and human capital accumulation (Blundell, et al, 1999), time-use collection offers many opportunities for more meaningful insight into work. In addition, as highlighted earlier in the paper, the growth of the sharing and gig economies open new questions for people's job qualities and work-life balance (Kalleberg & Dunn, 2016). Hence, it is important to capture a wider definition of working time that captures activities not typically captured as well in labour market surveys. For some of the considerations, see discussions in (Bean, 2016) and (Brinkley, 2016) where it is unclear if people would identify themselves as having a job when making some extra income for example from selling or renting out their property, and hence they may not be captured in total hours worked.

As there are some evidence people don't capture these wider work activities as well in traditional data collection, ONS piloted more specific work categories to capture these activities. In consultation with sharing and gig economy experts, the following list of activities was trialled:

- Providing childcare/cleaning/handyman/odd jobs for pay (exclude main job or delivery services)
- Selling your things, apart from home (e.g., Ebay)
- Leasing or renting things you own, excluding business
- Showing your own house/flat/building to potential buyers
- Using your private vehicle to earn money, including delivery services
- Writing online public blogs or reviews
- Writing open-source software for public
- Creating or coding a website
- Writing online/creating content for public
- Assisting others online e.g., forum
- Supporting a cause on social media or petition website

As can be seen, apart from the reference to Ebay, no specific companies or platforms were referred to, given the faster pace of change in such activities. The consideration was that the description should closely match what people were doing, as well as being able to find the category given the drop-down/search functionality of entering activities.

Across the 3 waves, around 8% of work diary episodes were from this wider set of work activities. In the third wave, this accounted for around 4% of total work time, so clearly, this is a significant effect

to add value to labour market statistics, as well as people's time-use more generally. There may also be interesting implications for welfare and well-being: these wider work activities were ranked higher on the 1 to 7 enjoyment scale, than the more traditional work activities. Since these activities are more likely to be part of the more informal gig or sharing economies, and hence not captured by the same legal considerations, it is interesting that people may enjoy this type of work more.

In addition to these separate activities, ONS considered what other activities in the activity framework may be selected instead of 'working', and hence undercounting total time spent focused on work. This was tested with 4 activities considered when people describe 'not being able to switch off' and became particularly relevant with a large proportion of the workforce working from home due to the pandemic. These were:

Table 7: Activities considered when people describe 'not being able to switch off'

Activity name	Notes for respondents
Browsing internet	Exclude browsing for shopping, select this as "shopping and errands" Exclude social media, select this as "using social media" Exclude producing things online, select these as "online creation" categories in "other computer and internet use" Exclude streaming videos, select this as "streaming tv programmes or…"
Reading books, magazines or newspapers	Exclude browsing internet information, select this as "browsing internet"
Checking email	
Checking or using social media	Include instant messaging here

Source: Office for National Statistics - Time-use survey

For each of these, the follow-up question was prompted: 'Was this for any kind of paid work?'. Including the times when people responded they'd done the above activities for paid work accounted for around 1% of total work time in wave 3, so again, this is a significant amount to consider for a more complete measure of time spent working. In addition, half of the episodes in wave 3 were outside of the traditional 9-5 work time so it does lend support to the hypothesis of certain tasks making it difficult for people to switch off. The authors do acknowledge the activities chosen are biased to more technologically based roles, so more work is needed to consider whether further activities are also being done for paid work outside of the main work categories.

As well as capturing wider work time, ONS wanted to test and explore the willingness of respondents to give more detail around their work time. This is to inform future work on determinants of human capital acquisition like training and feedback (ONS, 2019) and job quality. In addition, it allows ONS to consider verification of O-Net based measures of occupation detail for a UK context. To test this, a follow-up question for the activities 'working', 'working from home' and 'working from a café or other workspace' was shown for respondents in wave 1 to select tasks: 'What tasks were you doing?' with a list of options. This was well received, with no negative effects on response rates of employed or working time identified through telephone interviewer unit feedback. An average of 2.5 tasks were chosen in wave 1, with the most common being 'Emails', 'Day-to-day/business as usual/procedural at

desk' and 'Dealing with people'. 15% of respondents chose 'Other' among other tasks, which implied the list of tasks may not have been optimal. Getting feedback across the first two waves that there may be too much focus on desk-based jobs, a new list, based on O-Net, was used for wave 3. There is more work that needs to be applied to future collection, as 20% of respondents chose 'Other' this time. The most common tasks picked were 'Admin tasks', 'Meetings' and 'Dealing with customers or public'.

However, as respondents seemed comfortable with this follow-up, for wave 2, extra questions were also tested for work-time activities. One captured the equipment and devices people used at work, while the second was a list of factors related to human capital:

Table 8: Human Capital follow-up question, that was asked in wave 2 only

> During your work time, which of the following statements were true?
> Please check all that apply:
> - I received constructive feedback
> - I knew how to do the work
> - The work tested my skills and knowledge
> - I was motivated to do the work
> - I used the skills and knowledge I gained from my schooling and other education
> - I used the skills and knowledge I have gained from working
> - I used the skills and knowledge I have gained from outside of work or education
> - What I did helps me progress in my job and/or long-term career
> - My health was at risk from work
> - None of the above

Source: Office for National Statistics - OTUS

This was also well received, and no issues were identified with response rates for the employed. This was despite the fact the question is clearly quite burdensome, as each of the options is not as simple to determine and requires cognitive effort. This may be due to people willing to accept the burden as they value work as an important part of their day, but also because 'work' activity is generally only chosen a handful of times on each diary day. This is very positive for future collection of key factors influencing people's skills and knowledge acquisition at work, differences between home-based and workplace-based working, links to productivity and job quality.

5. Results to date from OTUS

Results for the OTUS project are evaluated by both the success in gathering quality data, and the reception or demand for the data produced in articles and publications. First, the quality of the data can be weighed up by considering response rates, how they differed across waves along with the iterative tool improvements and incentive tests, and by demographics, in line with the original aim of creating a representative and cost-effective survey. In addition, given the extra demand for insightful and timely data driven by the pandemic, considering the breadth of outputs and users impacted helps evaluate the immediate value OTUS has derived to decision-making and analysis.

5.1 Response rate and representability analysis

In order to start evaluating the pilot's future feasibility and success, it is important to consider some survey metrics. Here, the section focuses on response rates, and particularly response rates by demographics, talking about where the survey may have done well on representability, and where

future improvements may be needed. It is important to highlight how this type of analysis is greatly enabled by having a follow-up sample as the sampling frame, such that more detailed demographic representability could be considered. Note, this also allowed for more targeted weighting, taking account of non-response weights that differed across demographics.

Table 9: Overall, online and telephone panellists' response rates for wave 1 to 3, OTUS 2020-2021

	Total								
	Wave 1			Wave 2			Wave 3		
	Total	Online	Tel	Total	Online	Tel	Total	Online	Tel
Completed demographics	40%	39%	43%	35%	34%	39%	59%	60%	54%
Started any days	38%	37%	44%	41%	41%	39%	59%	60%	55%
Completed any days	32%	30%	43%	36%	35%	38%	55%	55%	55%
Completed both days	28%	27%	37%	31%	31%	32%	48%	49%	42%

Source: Office for National Statistics – OTUS

Results show a step-up in response across each wave, with a larger increase for wave 3 following more substantial improvements to the tool as outlined in section 3. Note, data collection changes should be considered as waves 1 and 2 panellists were selected from the British Social Attitudes and the Scotland Social Attitudes surveys, giving Scotland a boost to their sample size due to domestic policy needs. For wave 3, on the other hand, the panellists were selected only from the BSA, which did have a better average response rate across the first two waves, though an improvement is still seen between waves 2 and 3 when only compared BSA response rates. For example, 49% of BSA panellists completed any days in total for wave 2. Also wave 1 and 2 response rates include a first issue and a re-issue which contributed to increasing the response, while wave 3 did not have a first issue, along with all the improvements to the tool, it achieved a much higher response. This can be seen as the re-issues improved total response rates for completing any days by 5 percentage points. Comparing BSA-only, first-issue-only response rates completing any days from wave 2 with wave 3, the increase went from 42% to 55% in wave 3.

Other improvements can be seen in the drop-off rate of people who started the diary but did not complete it in wave 1, where about 15% of respondents did not complete a day even though they'd started one. By wave 3, about 7% were not completing a day they'd started, which supports the evidence that the tool was easier to navigate, on top of being higher quality as highlighted in sections 2 and 3. However, It is worth noting that there are still improvements to be made in integrating responses to the demographic questionnaire and the diary days, which provide analysis by key characteristics such as sex, age, region, ethnicity, employment status etc. This was particularly unsuccessful in wave 2 where the way the questionnaire was presented, in comparison to the diary days, was unclear for respondents, but generally seems to have been rectified by wave 3.

Analysis across the demographics show that in wave 3, a higher response was gained across all ages and household types, seen in the next two tables. In contrast, in past waves respondents who were younger, or adults with children, particularly single parents, weren't as well represented compared to respondents aged 35+ or adults with no children. The uptake in these demographics may have been

swayed by the higher incentives offered in wave 3 or the lower respondent burden from a quicker and more user-friendly survey, which further analysis needs to ascertain.

Table 10: Shows response rates split by demographic – Age, for wave 1 to 3

Wave 1	Age						
	Total	18-24	25-34	35-44	45-54	55-64	65+
Completed demogs	26%	23%	32%	37%	44%	47%	43%
Started any days	24%	22%	29%	34%	42%	46%	42%
Completed any days	20%	18%	24%	29%	37%	39%	35%
Completed both days	17%	14%	20%	25%	32%	34%	32%
Wave 2	**Total**	**18-24**	**25-34**	**35-44**	**45-54**	**55-64**	**65+**
Completed demogs	35%	26%	30%	37%	36%	35%	37%
Started any days	41%	28%	33%	43%	44%	42%	44%
Completed any days	36%	26%	29%	38%	38%	37%	39%
Completed both days	32%	21%	25%	32%	32%	34%	35%
Wave 3	**Total**	**18-24**	**25-34**	**35-44**	**45-54**	**55-64**	**65+**
Completed demogs	59%	55%	54%	56%	62%	63%	58%
Started any days	59%	54%	54%	57%	63%	64%	59%
Completed any days	55%	51%	50%	54%	60%	59%	52%
Completed both days	48%	39%	40%	45%	52%	54%	47%

Source: Office for National Statistics – OTUS

Table 11: Shows response rates split by demographic – Household Type, for wave 1 to 3

Wave 1	Household Type						
	Total	Single person household	Lone parent	2 adults (no children)	2 adults (with children)	3+ adults (no children)	3+ adults (with children)
Completed demogs	40%	38%	31%	46%	37%	37%	34%
Started any days	38%	37%	28%	44%	35%	34%	31%
Completed any days	32%	32%	23%	37%	29%	29%	25%
Completed both days	28%	28%	18%	33%	25%	26%	20%
Wave 2	**Total**	**Single person household**	**Lone parent**	**2 adults (no children)**	**2 adults (with children)**	**3+ adults (no children)**	**3+ adults (with children)**

	Total	Single person household	Lone parent	2 adults (no children)	2 adults (with children)	3+ adults (no children)	3+ adults (with children)
Completed demogs	35%	34%	27%	38%	35%	32%	33%
Started any days	41%	40%	36%	44%	40%	37%	43%
Completed any days	36%	34%	28%	40%	34%	33%	38%
Completed both days	31%	31%	22%	37%	29%	28%	29%
Wave 3	**Total**	**Single person household**	**Lone parent**	**2 adults (no children)**	**2 adults (with children)**	**3+ adults (no children)**	**3+ adults (with children)**
Completed demogs	59%	57%	57%	63%	55%	59%	57%
Started any days	59%	58%	58%	63%	56%	59%	59%
Completed any days	55%	53%	54%	58%	52%	54%	59%
Completed both days	48%	47%	44%	51%	44%	47%	49%

Source: Office for National Statistics – OTUS

Notes: Completed demogs = Respondent completed and submitted demographic questionnaire

Started any days = Respondent started any of their allocated diary days.

Completed any days = Respondent completed any one of the allocated days.

Completed both days = Respondent completed and submitted both days.

The improvement can be seen in the fact that those with children also had higher levels of drop-off in earlier waves, while in wave 3, the drop-off rate is similar across the categories, and particularly positive for adults with children and at least two other adults in the household, which may include multi-generational households.

Further improvements may be needed in single-adult and 2-adult households with children where the % completing both days is particularly low compared with households without children, which may imply the experience of having completed one day puts them off a second day, or it may imply the effort in completing a weekday and weekend day is similar for them more so than other adults, rather than easier. There may be a bigger effect from re-issues on such types of households too, if they are assigned a different day that they are more able to manage. Evidence for this comes from the fact the difference between % of respondents completed at least one day and both days is less stark in waves 1 and 2, when re-issues were running.

Drop-off rates due to sub-optimal user experience may still affect older age groups, as this comes across the three waves particularly for those 55 years and over.

Considering other demographics, improvements in wave 3 and particularly the incentives may also be applied for those with lower education levels. Respondents with no qualifications showed a positive change, the response for completed any days, more than doubled (46%) compared to previous waves (21%), while those with higher qualifications showed more similar response levels across the three waves. Sex, Ethnicity and Region all result in higher responses in wave 3 as well as good representation across all categories. Generally, there are little differences between sex and region, apart from a couple of NUTS-1 level regions that may relate to more local targeted explanation of how the survey may affect their lives. This is due to the devolved policy nature of the UK.

Further logistic regression and statistical analysis will be needed to undertake a full evaluation of representation and particularly the effects of re-issues and incentives, and how this may be translated into more targeted collection, documentation or incentives. However, indications are that the overall response rates for a time-use survey are respectable, and changes made to improve user experience and response burden have improved response rate and quality of the data collected. Hence, it should give other organisations attempting to collect such data, and future ONS projects, a helpful steer in which directions online collection may make for a better-quality survey.

5.2 Dissemination overview

Table 12: Time-use outputs

Output	Description	Period	Analysis Types
Coronavirus and how people spent their time under lockdown	A look into the behavior changes of differing demographics from pre-lockdown to during lockdown	2014/15 vs 28 March to 26 April 2020	Cross tabulation and significance testing.
Parenting in lockdown: Coronavirus and the effects on work-life balance	An analysis of how parents adapted their working patterns around their childcare commitments	28 March to 26 April 2020	Logistic regression, tempograms
How people spent their time after the March 2020 coronavirus lockdown	Analysis showing to what extent the UK had returned to normal behavior following the first coronavirus restrictions.	2014/15 vs 28 March to 26 April 2020 vs 5 September to 11 October 2020	Cross tabulation and significance testing.
How people with a vaccine spent their time - one year on from the first UK lockdown	An analysis of how behavior changed for those vaccinated and non-vaccinated using longitudinally linked data	March and April 2020 vs March 2021	Cross tabulation, longitudinal analysis and significance testing.
Time spent in lockdown split by working pattern and day type	Data tables showing the behavioral differences between individuals on working from home days, working away from home days and non-working days.	2014/15 vs 28 March to 26 April 2020	Cross tabulation and significance testing.
Homeworking hours, rewards and opportunities in the UK	Analysis looking into indicators of productivity and work success such as pay, and hours worked.	2011 to 2020	For work, looking into average start times, length of break and number of breaks.
Using data science to explore changes in behaviour and	A blog post documenting different methods of analysing behaviour changes and wellbeing using TUS data.	2014/15 vs 28 March to 26 April 2020	Tempograms and various data science techniques.

Source: Office for National Statistics - OTUS

5.3 Results

The Time Use study has been used to inform the public and influence government policy. Each wave of the survey has given rise to at least one Office for National Statistics (ONS) Time-use article, the exposure has led to a higher user demand for time-use data, both within other areas of ONS and externally to other government departments, academics, or researchers.
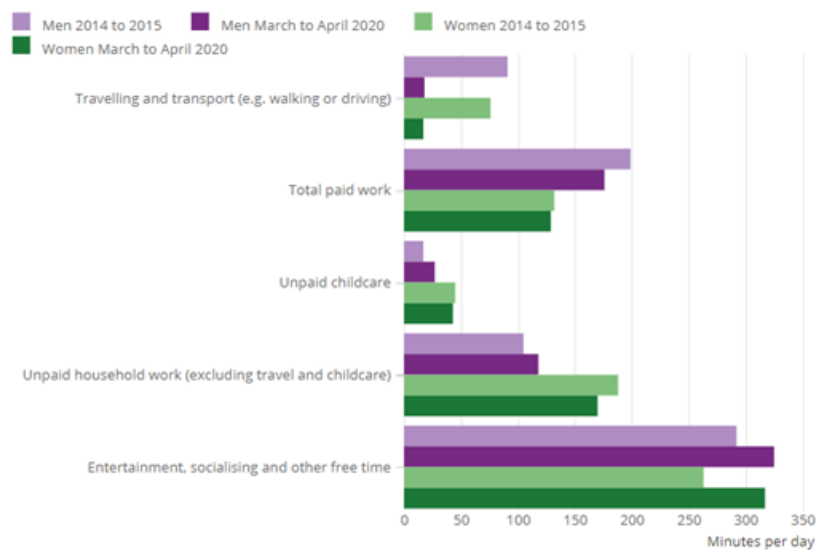
The general format for each article aggregates all 78 activities into 12 understandable higher-level categories, for example Unpaid childcare includes 4 activities such as feeding, washing, dressing, or preparing meals for children, reading, playing with, or helping children with homework, other childcare not elsewhere listed, supporting, comforting, or cuddling children, the higher-level categories allow the data to tell a story that can be more relatable to the general reader.

Analysis between time periods and demographics was deemed possible due to the seasonality work undertaken by the ONS' central analytical team volunteers, whereby seasonality in activity times were found to be negligible (see section 3.1). A time-use survey conducted in 2014/15 by Centre for time-use research (CTUR) is used as a baseline for pre-pandemic data, after the first wave of data was collected, analysis was carried out determining how behaviour had differed between pre and post pandemic times.

A key target for the time-use study is to capture how much time respondents spend doing unpaid work, below shows analysis of unpaid work which was undertaken to show how the gap between men and women's unpaid work had narrowed between pre-pandemic (2014/15 CTUR data) to post pandemic (wave 1, March 2020), the data highlights a drop from 1 hour and 50 minutes to 1 hour and 7 minutes a day for women doing more unpaid work.

Fig. 8: Shows analysis produced from the first publication, Coronavirus and how people spent their time under lockdown: 28 March to 26 April 2020

Minutes of main activity a day by sex for adults aged 18 years and over, 2014 to 2015 for the UK and 28 March to 26 April 2020 for Great Britain

■ Men 2014 to 2015   ■ Men March to April 2020   ■ Women 2014 to 2015
■ Women March to April 2020

Travelling and transport (e.g. walking or driving)

Total paid work

Unpaid childcare

Unpaid household work (excluding travel and childcare)

Entertainment, socialising and other free time

0   50   100   150   200   250   300   350
Minutes per day

Source: Office for National Statistics - OTUS

Further articles allowed for more specific forms of analysis, to target what the time-use survey was originally developed for, as well as more pressing Covid-19 related questions. Another article produced was around how the pandemic had affected parents' work-life balance, data showed that parents who had been able to work through the first lock down, had also adapted their working patterns around caring for their children.

The effect of the vaccine on individual's behaviour was also investigated. In wave 3 an additional question was added to the demographic questionnaire, the question asked respondents whether they had received at least one does of Covid-19 vaccine. It additionally came in useful that an option to longitudinally link the first and third wave was utilised. This enable analysis which showed how the same individuals who had been vaccinated had changed their behaviour a year on, and how this compared to a non-vaccinated sample.

Fig. 9: Shows some of the analysis produced in the latest publication, How people with a vaccine spent their time - one year on from the first UK lockdown: Great Britain, March 2021

Hours spent on main activity per day for people who received at least one vaccine dose and non-vaccinated adults aged 18 years and over, 28 March to 26 April 2020 and 20 to 28 March 2021 for Great Britain

Those who received **1+ dose of vaccine** by March 2021

● in March 2020 ● in March 2021

Those who had **not been vaccinated** by March 2021

● in March 2020 ● in March 2021
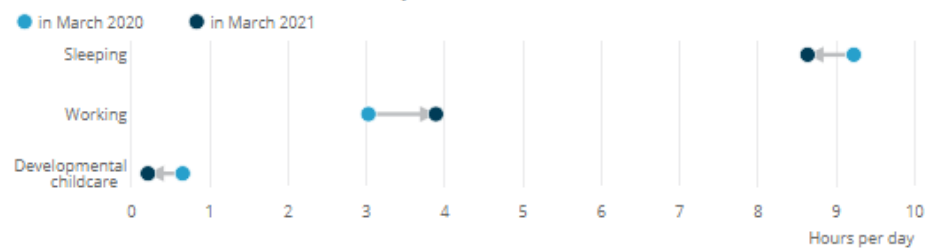
Source: Office for National Statistics - OTUS

The TUS has additionally been used to respond to specific questions from differing government departments – analysis of lockdown behavioural change and differences between working from home vs away from home have been undertaken.

6. Future work

With the pilot study now finished, and the core foundation of the survey embedded, a more full and robust assessment of the quality of the tool, and of the sample data needs to be undertaken. This will help definitively highlight whether the pilot was a success against its original and amended project goals. Early indications highlight the benefits of such data collection, and so subject to certain improvements, amendments or edits, ONS has plans for a further wave to go ahead later in 2021 or early 2022. Beyond this, further ways on a version of OTUS becoming a regular ONS data collection are being considered, subject to a proposal for a steadier collection tool allowing some flexibility to respond to evolving policy needs.

Another work stream planned for this year is making the dataset publicly available. This will be achieved by uploading the data to The UK Data Service, an online datastore aimed at academic researchers, students and research organisations. Given the pilot was experimenting with various elements of collection, it is likely that only a subset of the full collection will be made available for statistical outputs, subject to further investigations.

Additionally, there will be further changes to the tool to improve data quality and ease burden to respondents if it's to be used for future collection. Changes to the diary tool are being explored on how to obtain a respondent's location at the time of an activity. Currently, pop-up questions follow several activities asking if they are home or away from the home. Automation may be added for a few activities I.e., sleeping, where the assumption is that the respondent would be at home, this would enable the diary to collect more data without adding more questions for the respondent to complete.

6.1 Short term developments

There are plans to make several small changes to the diary tool. These edits are easier to implement as they only require analysing results of previous surveys or taking into account feedback from telephone interviewers. In some cases, potential changes to the diary tool arise when discussing other aspects of the tool and are noted down to be revisited when editing is taking place. Four areas have been flagged for small-scale edits since wave 3 of the survey went out: device use for exercise activities, enjoyment scores for paid work, analysing free text answers, and incentives for particular demographics.

Asking whether respondents use devices when exercising is an easy addition to the survey. There is already a pop-up question enquiring about device use for other activities such as socialising, watching TV or doing paid work. The use of devices during exercise had not been considered previously but with the growth of smart watch and similar device ownership, adding it to the survey could help us understand better how people engage in exercise as well as total device use.

The enjoyment scale for paid work was also noted down as an area for improvement. This is to better reflect the productivity of the work completed or a more meaningful subjective reflection of work time than 'how much you enjoyed work'. Instead of being asked for a number on an enjoyment scale, respondents may be asked for a number on a scale of fulfilment, or productivity. As with many other aspects of the survey, this change would be easy to implement digitally. However, much discussion would be needed to ensure it is a meaningful change, and understand future implications (for example, whether this could be compared with other enjoyment scores for activities, or with work enjoyment scores in previous waves).

Another step which may lead to further edits would be to analyse all the instances of respondents choosing "Other" as their answer to both pop-up questions and activities and grouping these answers to understand what options may be missing from drop-down lists of answers or activities. This would require a comprehensive analysis and further discussions of whether to make changes to the structure of the diary tool, or if there are any issues in the clarity of use.

Finally, there are plans for targeted incentives for demographic subgroups, to increase both the quality and number of diary days completed by these groups. For example, parents actively looking after children in the household may not prioritise a detailed survey such as OTUS unless a larger incentive is involved. To make this change effective, we would analyse demographic groups to understand which to target, and then increase the survey incentive based on the success of raising the incentive for previous waves.

6.2 Long term considerations

Some changes to the diary tool require a brand-new prototype, building on the experience of the pilot year to inform larger changes across the board. User needs for such changes have been recorded throughout the pilot, from before its inception to after the latest wave 3 results. These ideas include capturing location and co-presence data, collecting data specific to children and using GPS data to automate parts of the survey. None of these developments are certain to occur, but depending on appetite and funding, may be potential avenues in future.

At the beginning of 2021 experimental prototypes were developed to find ways of making the diary tool potentially easier for the respondent to fill in, based on multiple earlier rounds of feedback saying

parts of the tool were too burdensome to complete. Part of the strategy to make the diary tool more user-friendly was to incorporate automated answers as much as possible. This also presented opportunities to investigate the integration of measuring location and co-presence and was tested in two rounds with internal ONS user testers. Further user testing would be required.

Results so far suggest answers at the start of the diary day could create a starting location, with certain activities indicating a potential change in location and therefore triggering a follow-up question relating to this. For example, the new diary tool would assume respondents started their day at home, and this location would automatically be recorded for subsequent activities, until the respondent enters a travel activity. The instance of travel would trigger a new location pop-up question, and this location would be assumed to stay constant until a further instance of travel. Alternatively, if an activity that typically may have been done outside of the home is selected, such as shopping face-to-face, the location will be amended and a specific question on the length and mode of travel to get to the new location would be requested. Considering co-presence, partial automatic completion that required verifying could also then prompt respondents to say who they were with. This may enable an alternative way of capturing passive care, too. Conceptual questions remain around defining what it means to be 'with' someone (e.g. user testing highlighted how the answer may change depending on the activity being done and the context, such that if you were having a shower you would not say you were with other people who were in the rest of the house, while if you were having a party, you would treat all the people in the house with you as 'being with you') The logistics of incorporating this type of change into the diary tool is complex, which is why it would require a new diary tool format and further rounds of user testing.

Collecting data specifically relating to children has also come across as a wider user need. Both collecting more information on parents' interactions with their children outside of formal care situations (e.g., if they watched TV together, ate meals together, exercised together etc), and collecting independent information on children's time-use, all entail more large-scale changes. The diary tool would need to be adapted to be suitable for children to fill in, with the aim of recording activities relevant to children's wellbeing, development and general homelife. In addition, the functionality and detail of information required may need to be modified for children reflecting their differing levels of attention, language understanding and even digital familiarity. In turn, the data could identify areas for policy makers to intervene, provide help or improve development opportunities. This concept is in very early stages and would need in-depth collaboration with relevant government departments and stakeholders.

Finally, the use of GPS to automate parts of the diary tool has been a potential direction of development since the initial stages of planning the initial tool. In essence, obtaining consent from respondents to use their GPS data would mean some sections of the diary tool could be automated, such as location and travel, with relevant pop-up questions appearing based on physical location. It could also be helpful as a recall tool to remind people where they have been, or to indicate more accurate durations of activity. Again, this is a complex and sensitive development which would require further research, as well as an understanding of respondents' willingness and trust in sharing their location data. Specific considerations around Government Data Protection Regulation (GDPR) would need to be applied about if and how such data is stored and linked to their time-use, in an ethical and secure way.

7. Conclusion

Overall, OTUS has been relatively successful in meeting its ambitious targets set out before the first wave of the survey. The first, and highest priority for OTUS was to see if it was possible to measure

time-use in a representative and cost-effective manner. This was largely achieved by ensuring collection methods were as representative as possible, and this improved across all three waves as monetary incentives were introduced and the survey was made easier and quicker to complete, lightening the respondent burden. In addition, drop-off rates decreased. By wave 3, respectable levels of response were achieved, given that time-use surveys tend to be detailed and burdensome by nature. As well as this, the survey was developed in line with web accessibility standards from the offset.

However, there is still work to be done to make the survey more representative. As discussed, the survey is complex and can be a burden for those short on time, which reflects lower response rates for demographic groups such as parents. Also, while the response rates for younger age groups increased over time, further work is needed to ensure overall representation is of highest quality, and this includes increasing representation from groups such as diverse ethnic communities, those with disabilities and the LGBTQ community. This is a problem related to cost, as a larger, potentially targeted survey sample or targeted engagement and incentives, may likely be part of the solution. It is also worth noting this is an issue UK social surveys are dealing with in general (see work by UKSA, 2021). On the whole, OTUS, through many developments, has proved it is possible to create a representative and cost-effective mixed-mode time-use survey in Great Britain, and this pilot is a good foundation on which to make further improvements.

Second, as the Covid-19 pandemic came to prominence, a high priority for OTUS was to track the real-time behavioural changes occurring in the UK in response to evolving government restrictions. OTUS was highly successful in this area, and was in great demand, regularly responding to requests from government departments and publishing articles to inform the wider public and media. This was despite considering the complexity of the data and the multiple changes made across waves as part of running a pilot survey. Timely and informative publications included those covering topics such as the gender gap in unpaid work, the effect of Covid-19 vaccines on behaviour and how much time parents spent on childcare within the context of government restrictions (such as school closures). Over the 12 months of running the pilot survey, five articles and several ad hoc departmental requests were published on the ONS website and elicited a wider range of governmental, academic and media interest and coverage. OTUS has become a flagship survey within the ONS, not only as an alternate method of economic measurement, but as a key indicator of the effects of policy change regarding Covid-19.

Third, OTUS set out to understand the extent of unpaid work in the economy and its distribution between demographic groups, such as men and women. This was also largely successful, and findings on differences between the sexes and between parents and non-parents were published as outlined above. Gender gaps in unpaid work were found to have decreased in the earlier stages of the pandemic when schools and most of society was shut, but even by September/October 2020 when parts of society started re-opening, the gender gap started widening again, raising concerns about the structural lack of opportunities in women achieving their work-life balance.

However, the OTUS has also grappled with difficulties in accurately measuring unpaid work, particularly in terms of responses to time spent on passive care. Developments in the survey have reflected these issues, however more work is required to achieve the quality measurements envisioned at the outset. Despite these challenges, the OTUS has been a key source of information regarding unpaid work, and this angle of investigation has been popular in resulting media coverage.

Fourth, the OTUS was an experiment to see whether time-use could be helpful in attaining more complete measures of paid work by including aspects of gig and sharing economies. The structure of

the diary tool has enabled respondents to record time spent on these types of activities and they account for substantial levels of work time, potentially as high as 5% of paid work time compared with more traditional labour market measures. In addition, respondents were clearly willing to expand upon what they do at work, which equipment they use, and how this relates to human capital acquisition despite the extra burden. However, further analysis of free text options (when respondents selected "Other" instead of the listed activities) would reveal any areas for improvement in capturing these categories in appropriate ways.

The fifth goal was to understand whether it was possible to collect information on device use and related measures such as screen-time, and whether digital service provision is changing people's habits. At first the OTUS was designed to capture device use with separate questions, however after it became apparent this was too cumbersome for respondents, and there was overwhelming duplication with follow-up questions for device use during certain activities, the survey was adapted to ask about device use only with pop-up questions related to specific activities. This was a far more successful strategy, and consequently data was captured relatively well.

Overall, the OTUS has overcome many logistical challenges to meet the aims set out above. By adapting to feedback, analysing results and committing to an iterative development model, the survey has improved across all three waves and become a successful tool for measuring time use. In future there are more steps that need to be taken, but at this point it is hoped the OTUS provides a positive example for how to create a feasible time use survey online, which responds effectively to policy needs as well as the evolving perceptions of the economy.

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9. Annex

Table 13: First proposed version of the activity framework

High-level Activity	Low-level-activity	Notes for respondents
Personal care	Sleeping	Include intending to sleep or trying to sleep
	Resting (doing nothing, 'time out')	Include doing nothing, sitting thinking, smoking breaks
	Washing, dressing/undressing, etc	Include make up, beauty treatments, taking medication

Category	Activity	Notes
Eating, drinking	Eating or drinking/ having a meal (at home or away from home)	Include meals, snacks and drinks
Housework and other household tasks	Preparing food and drinks, cooking, washing up	
	Cleaning, tidying house	
	Washing, ironing or mending clothes etc	
	Maintenance of house, DIY, gardening	
	Pet care (including walking the dog)	Include dog walking but also code travel as secondary activity. Include going to the vet
Travel	Travelling	
	How you travelled (enter letter - see right page)	a Car/van, Walk/jog, Pedal bicycle, Bus/Coach, Train/underground, Other
	Type of trip (enter letter - see right page)	Escort e.g., a journey purely to escort someone (and that you otherwise would not do), Just walk/drive/cycle e.g., a run in the car or a walk purely for enjoyment, Paid work, Shopping or Other
Work for paid job	Work for job (include paid and unpaid overtime. Exclude lunch and other breaks. Exclude activities related to 11b to 11f. Working from home should be coded as 11d.)	Travel in the course of work (e.g., to get to a meeting, a plumber driving to a job); record work as main activity and travel as secondary. However, do not record work travel for people who earn their living by travelling e.g., bus driver, delivery person
	Using your own personal vehicle to earn money (excluding travel for the sole purpose of commuting and journeys in vehicles registered for business use)	This makes use of personal vehicles, offering additional flexible income for households where they might struggle to commit other types of additional work.
	Activity related to the provision of personal room sharing services (preparing rooms for guests, updating room advert or related host profile page)	This makes use of spare rooms personal vehicles, offering additional flexible income for households where they might struggle to commit other types of additional work.
	Working from home, a café, or other workspace not paid for by your employer.	This makes use of household utilities or utilities outside of the office, reduces the need for office space and therefore reduces office costs.
	Activities related to providing storage/parking space for payment.	This makes use of additional household space, providing income by offering a space otherwise inaccessible to the public.
	Providing handyman/odd jobs/delivery services for payment but not as part of a contractual form of employment or regular form of self-employment.	For example, TaskRabbit. This makes use of personal skills and free time, offering additional flexible income for households where they might struggle to commit to other types of additional work.
Education and courses	Formal education	Studies as part of formal education, including general and vocational training
	Recreational courses and study	Recreational courses and informal study activities or self-improvement
Voluntary work	Voluntary work for or on behalf of an organisation, charity or sports club	Include work on behalf of political organisations. Include helping, caring or nursing other people if done for a voluntary organisation or charity
Caring for children and adults	Caring for/looking after and playing with own children	Include step/adopted/foster children. Childcare takes precedence over any other secondary activity
	Caring for/looking after other children	Exclude caring for children as part of job (e.g., childminder, nursery assistant)
	Helping or caring for adults who live with you	Include caring for spouse or partner
	Helping or caring for other adults who don't live with you (not as voluntary or paid work)	Includes helping neighbours or friends
Shopping and appointments	Visiting high street shops to buy a specific product or service	

	Visiting high street shops to browse/research products to purchase later	
	Visiting high street shops just for leisure/window shopping	
Leisure	Watching TV and DVDs, listening to radio or music	
	Streaming tv programmes or watching clips on the internet (for example, watching Netflix, Now TV or YouTube)	
	Reading	
	Playing sports, exercising	Include jogging or walking for exercise here code travelling as secondary activity
	Spending time with friends, family, neighbours at home or at their homes	
	Going out with friends, family, neighbours (e.g., to the pub, restaurant etc.)	Include unplanned contact in person e.g., meeting a neighbour in the street
	Contact with friends and family by telephone, text, e-mail, instant message or letter	
	Visits to cinema, theatre, concerts, sporting events, museums, galleries, historical monuments, library etc.	
	Attending church, temple, mosque, synagogue, or other religious meetings, praying alone, attending political or other meetings	
	Hobbies and other leisure activities	
Computer and internet use	Browsing online to buy a specific product or products	
	Browsing online to browse/research products to purchase later	
	Browsing products online just for leisure/window shopping	
	Unpaid online writing of blogs or reviews for a public audience	
	Unpaid marketing/showing of your own residential property for sale purposes, as opposed to using an estate agent	
	Unpaid writing open-source software for public use	
	Unpaid online writing/creation of information for public use	for example, contributing to Wikipedia or providing a video tutorial
	Unpaid assistance of others through online channels	for example, providing an answer to a question on a forum discussion
	Unpaid support of a cause on social media or petition website	for example, posting links to a charity campaign or signing up to an online petition
	Using a computer for other purposes (not elsewhere listed)	
Other	Other activities not listed (please write in below)	
LOCATION	Where were you? At Home (incl. the garden) or elsewhere. Give for each activity	

Source: Office for National Statistics - OTUS

Table 13: Activity framework used in wave 1

High-level activity	Lower-level activity	Notes for respondents (if hover over activity?)
Sleeping, washing, dressing or using the bathroom	Sleeping	
	Washing, showering, getting ready, using the bathroom, etc	Also includes other personal hygiene, getting ready to go to bed, make-up, taking medicines
Eating, drinking, cooking	Eating/eating out/take-away (e.g., breakfast, lunch, dinner)	
	Making food and drinks, cooking or washing up	Including for other people when unpaid, otherwise capture as working and other activities for pay
	Snacking	
	Drinking (e.g., tea, coffee, alcohol)	Includes having tea or coffee, as well as drinking alcohol
Work and other activities for pay	Working	Include paid and unpaid overtime. Exclude lunch and other breaks. Exclude other work-related activities below. Working from home should be coded as "working from home, …".
	On a work break (e.g., lunch)	
	Working from home, café or other workspace	Includes working outside if at an area not typically considered your workplace
	Providing childcare/cleaning/handyman/odd jobs for pay (exclude main job or delivery services)	For example, like TaskRabbit. This makes use of personal skills, your free time, and potentially your own assets like power tools, but excluding your car, offering additional flexible income for people
	Leasing or renting things you own, excluding business	This makes use of assets you own, like a spare room, storage/garage space, power tools, furniture or clothes, offering additional flexible income for households. For example, preparing rooms for/welcoming guests, updating online adverts or related host profile page
	Using your private vehicle to earn money, including delivery services	This is when you use your car, van or other vehicle to earn some money by providing others with your vehicle services. Excludes travel for the sole purpose of commuting and journeys in vehicles registered for business use
	Showing your own house/flat/building to potential buyers	This is for the purposes of selling your house. Selling of other items is the category below
	Selling your things, apart from home (e.g., Ebay)	This includes loading up information online, marketing, and other activities for the purpose of selling your clothes, furniture, digital goods etc.
Travel/Getting around (e.g walking, driving)	Travel/Transport (e.g., walking, driving)	Includes travelling to and from locations, escorting others or being escorted yourself, including taxi or bus for example
	Packing, preparing for journey	This includes preparing suitcase, loading items into luggage, unpacking when returning from a journey or similar

Housework, DIY, Gardening and Pets	Cleaning, hoovering, tidying house	Including for other people when unpaid, otherwise capture as work and other activities for pay
	Washing up	Including for other people when unpaid, otherwise capture as work and other activities for pay
	Ironing, washing or mending clothes etc	Including for other people when unpaid, otherwise capture as work and other activities for pay
	Repairing, maintaining or making household goods, or vehicles	Includes building and assembling shelves, furniture and other fixtures, own car repair or similar. Including for other people when unpaid, otherwise capture as work and other activities for pay
	Caring for or playing with pets (including walking the dog)	This includes playing with animals, training them, cleaning and feeding them and other similar care. Including for other people when unpaid, otherwise capture as work and other activities for pay
	DIY or Gardening	Including for other people when unpaid, otherwise capture as work and other activities for pay
Volunteering	Volunteering as part of a group, organisation, charity or sports club	Include volunteering work on behalf of political/religious organisations. Include helping, caring or nursing other people if done for a voluntary organisation or charity. If volunteering not through an organisation, you can code as adult care or childcare. Include any informal volunteering not through an organisation if not listed elsewhere in the activity list.
Caring for and looking after children and adults (not as paid job)	Feeding, washing, dressing or preparing meals for children	Include step/adopted/foster children. Childcare takes precedence over any other secondary activity. This includes washing, feeding and cleaning children.
	Reading, playing with, or helping children with homework	Include step/adopted/foster children. Childcare takes precedence over any other secondary activity. Include playing video games with children into the gaming category
	Supporting, comforting or cuddling children	Include time cuddling with children or being present to comfort or support them
	Time with child in your care (secondary activity)	This includes all the time that you have a child in your care (please record this time in your secondary activities only)
	Other childcare not elsewhere listed	
	Helping, caring or looking after adults	Include caring for spouse or partner, as well as helping neighbours or friends (age 18 or over)
	Time with an adult in your care (secondary activity)	This includes all the time that you have an adult (age 18 or over) in your care (please record this time in your secondary activities only)
Shopping and errands	Buying something, shopping	Includes regular online shopping for groceries, as well as making bookings
	Browsing things to buy later	Later refers to any time in the next 12 months
	Window shopping	

	Banking/Household errands/appointments including GP and dentist	e.g., bank, finance advice, haircut etc
Free time, entertainment & socialising, including on computer	Watching TV, Blu-ray or DVDs	
	Streaming TV or videos on the internet for entertainment (e.g., Netflix, Now TV or YouTube)	
	Listening to music, podcasts, audiobooks	
	Playing games/ computer gaming	
	Checking or using social media	Include instant messaging here
	Browsing internet	Exclude browsing for shopping, select this as "shopping and errands"
		Exclude social media, select this as "using social media"
		Exclude producing things online, select these as "online creation" categories in "other computer and internet use"
		Exclude streaming videos, select this as "streaming tv programmes or…"
	Checking email	
	Reading books, magazines or newspapers	Exclude browsing internet information, select this as "browsing internet"
	Socialising, spending time with friends, family, neighbours and colleagues	Include unplanned contact in person e.g., meeting a neighbour in the street. Also include going out with work colleagues. For example, to the pub, restaurant etc
	Just talking with spouse, children or parents, family, friends or neighbours	Include times which you wouldn't call a social occasion but include talking socially to others
	Telephoning, texting, emailing or writing letters with friends and family	
	Visits to cinema, theatre, concerts, sporting events, museums, galleries, library etc.	Include VR and online visits to galleries, sporting events and museums, historical monuments
	Attending religious event or meeting	
	Attending a political meeting	
	Hobbies and other leisure activities	
	Resting (doing nothing) or in bed not asleep	Includes daydreaming, lying awake or being ill in bed, intimacy
	Taking other form of leisure time	
Exercise, health and being active	Gym, fitness, and exercise classes	Select travelling as secondary activity
	Running or jogging	Select travelling as secondary activity
	Playing team sports	Select travelling as secondary activity
		Capture football, rugby, cricket, hockey, tennis and other sports played with others
	Playing other sports and exercising, including hiking	Include walking for exercise here. Also include dancing, swimming, climbing, intensive yoga and other solo sports here
		Select travelling as secondary activity
	Meditating, having a massage, spa or well-being treatments	Includes mindfulness and less intensive yoga here
	Other health or well-being activity	
Education and study	Attending formal education, lectures, classes, university (not for leisure)	Studies as part of formal education, including lectures, planned discussions, and planned workshops in general and vocational training. Self and group study associated with formal education in category 14

	Taking a course for fun	Recreational courses and informal study activities or self-improvement
	Studying, revising or homework time	Includes self and group study, researching for educational/self-improvement purposes, writing up assignments and homework
Other computer use, using directions and creating online content	Writing online public blogs or reviews	
	Writing open-source software for public	
	Creating or coding a website	
	Writing online/creating content for public	for example, contributing to Wikipedia or providing a video tutorial
	Assisting others online e.g., forum	for example, providing an answer to a question on a forum discussion
	Supporting a cause on social media or petition website	for example, posting links to a charity campaign or signing up to an online petition
	Using a device for directions	For example, taking directions, following instructions
	Finding guidance on internet e.g., YouTube or websites	For example, learning to cook a new dish or finding out how to repair something
	Using a computer for other purposes (not elsewhere listed)	
	On computer (no main purpose)	
Other or personal	Other activities not listed	If private time, then please write 'personal'
	Completing the diary	

Source: Office for National Statistics - OTUS