How do we spend our day in a digital world? An exploration of how digitalization influences time use in American society.

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ABSTRACT

This paper explores the impact of the information technology revolution of the 21st century on the way American society spends its time. Continuous digitalization drives huge changes on day-to-day life and everyday activities. This report aims to visualize any changes in time-spending trends among American society which can be attributed to digitalization, finding an answer to the question: Using ATUS data, how has the information technology revolution of the 21st century affected the way Americans spend their time? To do this, data from the American Time Use Survey between 2003 and 2019 was used with a focus on the following activities: sleeping, socializing, TV-use, PC-use and exercising. Alteryx was used to (pre)process the data and Tableau was used to visualize the data and to create an accompanying dashboard. Our findings suggest that Americans tend to experience more sleeplessness, watch more TV, play more computer games, and participate less in exercise and sports. This report discusses these findings, proposes certain courses of action, and acknowledges the limitations of the study.

CONTENTS

1 INTRODUCTION

The American Time Use Survey (ATUS) is a survey conducted by the U.S. Bureau of Labor Statistics, the primary fact-finding agency for the American government in the broad field of labour economics and statistics [1]. The ATUS measures the amount of time Americans spend doing a wide range of activities, such as eating, waiting, volunteering, doing homework, and relaxing [2]. In total, the ATUS consists of 456 variables, all describing different activities and demographics of the respondents. The paper presented here will concentrate on those activities that are deemed most affected by the information technology revolution of the 21st century.

This revolution has made most of society more connected than ever, with the youngest generations unable to imagine a less connected, non-digital life. The introduction of Facebook (2004), Gmail (2004), YouTube (2005), Twitter (2006), the iPhone (2007), and Netflix (2007) has however barely been 20 years ago. Within merely two decades, these digital inventions have affected the world in an unfathomable way. Kemp [3] finds that in 2019, on average, internet users spend 6 hours and 42 minutes online per day, Twenge [4] voices that the arrival of smartphones has radically changed every aspect of teenagers' lives, and in 2021 more than 80% of the world's population owned a smartphone [5].

Whilst the benefits of this revolution are numerous, it has also led to growing concerns about possible associations between spending time online and society's physical and mental health. This paper does not explore these negative associations, but rather investigates to what extent the developments of information technologies have affected the structure of daily life in the United States. The research question of this paper is therefore as follows: Using ATUS data, how has the information technology revolution of the 21st century affected the way Americans spend their time? We aim to formulate an answer to the research question by offering insights into how time spent has developed over the years, and whether there are any considerable changes observed.

In addition to this report, we created an interactive dashboard encompassing the entire ATUS dataset [6]. This dashboard contains the activities and filters used in this report to find an answer to the research question, but is not restricted to them. Consequently, the dashboard user can explore time use among American society in a much broader sense than merely in the context of this report.

The target group for this paper and its accompanying dashboard is the U.S. Department of Health and Human Services (HHS). HHS states that their mission is "to enhance the health and well-being of all Americans, by providing for effective health and human services and by fostering sound, sustained advances in the sciences underlying medicine, public health, and social services." [7]. They oversee the promotion of the well-being and health of Americans, with 11 operating divisions and more than 100 programs across the agencies of the department [8]. Because of the HHS' focus on public health, we are providing them with this research, enabling them to get an overview of the way Americans spend their time in a digital world. It must be noted that this report should not be viewed as a call-to-action, but purely as an objective exploration of the data paired with several suggestions for future measures and further research.

2 CONCEPTUAL FRAMEWORK RELATED WORK

The ATUS dataset consists of 219,368 records and includes 456 variables representing different activities and demographics of the respondents. Hence, the dataset gives a basis for the exploration of numerous different topics, resulting in many previously conducted studies using the ATUS dataset. The topics range from evaluating the development of childcare measures over time [9], to measuring commuting behaviour [10] and analysing cyclical variation in labour hours and productivity [11]. Additionally, more comprehensive studies have been conducted, such as a report by Deloitte [12], describing what Americans to do with their time in general, covering a wide range of topics. To the best of our knowledge, there has been no previous research where changes in time spent are put in the context of the information technology revolution of the 21st century.

The activities in the dataset are represented by activity codes of six digits. The first two digits describe the major category of the activity, the first four digits describe the second-tier category of the activity, and the six digits altogether specify the actual activity. In order to find an answer to the research question, we decided to focus on those activities whose variation we deem to be connected to the information technology revolution of the 21st century. The selected activities are, in no particular order, (1) sleeping, (2) socializing, (3) TV-use, (4) PC-use and (5) exercising. The rationale behind this selection is described below.

Hypothesis 1: The first activity we investigate and analyse is sleeping. Good sleep is essential to good health, and for most people, sleeping is one of the longer activities of a day. The general perception in society is that extensive use of technologies (read: high screen time) affects both sleep quantity and quality. Concerns are highest for young children and students since these are the generations growing up alongside the developments of IT. These perceptions emerged because research shows there may be reason for concern. A study conducted among Swedish high school students [13] reports that using technology significantly predicted a shorter sleep duration, and a study conducted on high school students in New York [14] reports that those students using technology most frequently, especially right before bed, report the lowest sleep quality.

In the ATUS, the activity code 010100 corresponds to the activity of sleeping, and the value represents the number of minutes the respondent has spent on sleeping on a certain day. Using this variable will allow us to investigate the development of time spent on sleeping and validate whether our data supports the results of previous literature. Based on this literature, we hypothesize the following:

H1: The number of minutes spent on sleeping has decreased, especially in adolescents.

Hypothesis 2: The second activity we investigate and analyse is socialization. With the emergence of social media and other technological developments, it is a well-known fact that the world is now more connected than ever. We are constantly in touch with friends and family from all over the world over a mountain of different apps. But what about the time we spend on interacting with others in real life, has that changed in the last decade? Research suggests it does. Twenge, Spitzberg and Campbell [15] find that adolescents in the 2010s spend less time on face-to-face interactions with their peers compared to previous generations. Other research, however, proposes that there is a positive relationship between digital media and in-person interaction. Dienlin, Masur, and Trepte [16] find that increased social media use leads to increasing in-person interactions within six months. Again other research suggests that, using the ATUS, it is unclear whether Americans are spending less time on face-to-face socialization now, compared to 20 years ago [17].

In the ATUS, the activity code 1201 corresponds to the activity of socializing and communicating. The value of this activity includes all minutes that a respondent has spent on physically socializing and communicating with others. In addition, there is a separate variable with activity code 1202 describing the number of minutes spent on attending and hosting social events. To fully encompass real-life socializing, these two activity codes were grouped together with activity codes 1205 and 1299, which are respectively associated with waiting for social events and socialization that has not been classified elsewhere. All sub-activities were included except for "attending meetings for personal interest (not volunteering)" since it was unclear what this variable exactly represented. Using this grouped variable allows us to objectively explore whether Americans are spending more, less, or a similar amount of time on face-to-face socialization. Since the findings of literature are diverging, we predominantly base our hypothesis on the general conception that people spend less time on face-to-face interactions because of increased screen time:

H2: The number of minutes spent on physically communicating and socializing with others has decreased.

Hypothesis 3: The third activity we investigate and analyse is TV-use. With the rapid developments in information technology during the 21st century, it is assumed that the youngest generations do not watch as much regular television as previous generations. Nowadays there are many more entertainment platforms available, which would keep them away from regular television. Twenge, Martin and Spitzberg [18] find that adolescents in the 2010s spend significantly less time on watching TV compared to adolescents from previous decades, and, compared to the 1990s, high school students spend an hour less time watching regular TV in 2016. Lee, Wescott and Böhm [19] find that for many years, broadcasters' percentage of video-watching hours on traditional TV have been falling in the UK, with a decline of more than 10% from 2019 to 2020.

In the ATUS, the activity code 120303 corresponds the activity of watching TV, and the value represents how many minutes of watching TV the respondent has engaged in on a certain day. This includes all types of watching TV, meaning it encompasses watching regular television, watching videos on YouTube, and watching movies. There is a separate variable for watching religious television which we grouped together with the initial variable, in order to include all activity related to television consumption. Since the literature tells us that the share of watching regular TV has decreased, but the variable in the dataset includes all types of watching TV, we hypothesize the following:

H3: The number of minutes spent on watching TV has remained equal.

Hypothesis 4: The fourth activity we investigate and analyse is PC-use. With the development of the popular social media platforms and technology developments within the work space, it is common knowledge that the use of computers has skyrocketed over the past decades. Ryan [20] finds that in 2000, 51% of all American households owned a computer, and that this had risen to 79% in 2015. Research by the Nielsen group [21] extends this as they find that in the first quarter of 2020 American adults spend more time than ever online. They find that over the past three years the time spent on interacting with media has increased by 1 hour and 15 minutes in American society. Breaking these results down, the number of minutes on all types of online media had increased, except for the radio, for which it had decreased.

In the ATUS, the activity code 120308 corresponds to the activity of leisure time on a personal computer, and the value represents how many minutes the respondent has spent on social media and personal computers

on a certain day. Based on the literature, we hypothesize the following:

H4:The number of minutes spent on a computer has increased.

Hypothesis 5: The fifth and last activity we investigate and analyse is sports and exercise. In society there is a growing concern that due to the developments in information technologies, people are not spending enough time on sports and exercise, negatively affecting their general health and well-being. These concerns are most prevalent for children and adolescents since they are growing up along with the information technology developments. The concerns evolve because research by the World Health Organization suggests that most adolescents all over the world are not getting enough exercise as screen time is replacing physical activities [22] [23]. Alongside of that, research shows that youth who are not physically active during the day are less healthy, both physically and mentally [24] [25], pleading for the aforementioned concerns.

In the ATUS, the activity code 1301 corresponds to the activity participating in sports, exercise, or recreation. This variable encompasses all activities that have to do with sports and corresponds to the value of the number of minutes respondents have spent on any physical activity on a certain day. Based on the literature, we hypothesize the following:

H5: The number of minutes spent on physical exercise has decreased, especially in adolescents.

3 METHODOLOGY

The overall process of the data analysis conducted in order to put forward an answer to the research question of this paper is presented in Figure 1 on page 3. In general, the process can be split into three distinct stages.

1. Data acquisition and dataset description
The dataset used for the analysis is the Multi-Year ATUS Summary File, from now on, MainActivityFile. The ATUS is an extensive survey about time use in American society. The collection and subsequent processing of the survey data is sponsored by the Bureau of Labor Statistics and conducted by the U.S. Census Bureau [26]. The US Bureau of Labor Statistics is built upon several core values which include, among others, focusing on facts, complete transparency, confidentiality, and gold-standard data [27]. Accordingly, it is deemed safe to assume that the trustworthiness and accuracy of the data is high and ready for use, and that the sample is representative of American society, making our results highly generalizable. The data collection by the US Bureau of Labor Statistics mainly consists of phone call interviews through a Computer Assisted Telephone Interviewing system, where the respondent was asked about their activities during the day.

The dataset is publicly available on the website of the US Bureau of Labor Statistics [28] and is stored as a ".dat" file. The dataset covers a timespan from 2003 until 2020, where the total number of rows(the number of interviews conducted) is 219.368. The dataset consists of 456 different columns, of which 432 are the different activities and the remaining 24 columns contain identifying information about the respondents' demographics, such as age and gender. Many of the variables and values stored in the dataset are described with a numeric code, and not a name. Therefore, in addition to the main dataset, we used two additional datasets from the US Bureau of Labor Statistics to translate activity codes into actual activities and to translate ethnicity codes into the name of the ethnicities. Both lookup tables were stored as CSV files.

2. Data (Pre)Processing
Data Pre-Processing is an important step in any Extract, Transform, Load

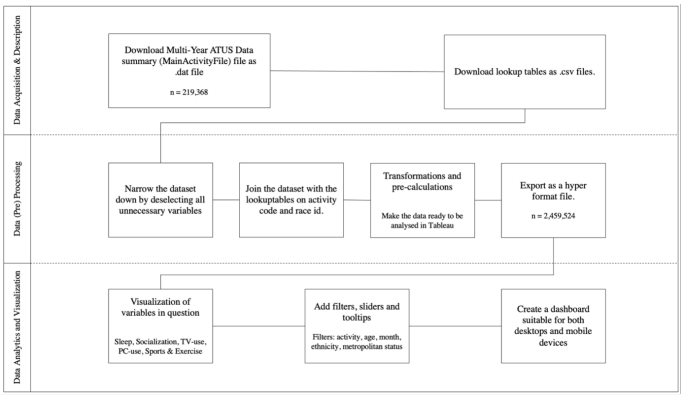

Figure 1. Overview of Data Analysis

(ETL) process. In this process the data gets cleaned, transformed, and joined together to create a ready-to-use final dataset for the final analysis. The chosen tool for the ETL process is Alteryx. Alteryx is used because of its easy-to-use interface, allowing us to transform the data without much programming. Furthermore, Alteryx helps to create an overview of the data and transform it according to our needs.

The MainActivityFile comes in a wide format, meaning the data is structured with a single row for each interview and a column for each activity. While working with this dataset, we want to work with the data in a long format, where each activity is in a separate row. Therefore, we transposed the data, converting the columns with the activities into rows. When transposing the 432 activity columns, they are transformed into two columns: one containing the activity code derived from the previous column name and one with the number of minutes that the respondent spent on the activity. The activity code is the letter t followed by a 6-digit activity code that identifies the given activity. After transposing the data, we got 26 columns as opposed to 456 columns and 94.547.608 rows as opposed to 219.368 rows. The number of rows is high, because for each interview every activity is a row, even though the respondent might not have participated in the activity, resulting in numerous rows having 0 minutes spent on an activity. During our analysis, we look at the number of minutes the respondents spend on each activity, divided by the number of people that have participated in the activity. Therefore, we decided to filter out the rows which included 0 minutes for an activity, resulting in 2.459.524 rows.

As mentioned before, the MainActivityFile contains data from 2020. The website of the US Bureau of Labor Statistics states that the data collection was suspended from mid-March to mid-May in 2020, due to the COVID-19 pandemic [29]. Additionally, due to this same pandemic, we strongly feel that 2020 should be considered an outlier. Consequently, we decided to drop the data from 2020. Additionally, we dropped those columns covering demographics that we were not interested in exploring and we changed the datatypes of several columns into integers to ensure computability in Tableau. The variables we decided to retain are:

1. TUCASEID: a unique identifier that we call "Id", that identifies the person on a given date.
2. Name: a variable describing the activity.
3. Value: a variable describing the number of minutes that the activity has been done.
4. Month: a variable describing the month in which the activity was performed. We extracted the month from the unique identifier "TUCASEID", as the month corresponds to the 5th and 6th characters of the ID.
5. GTMETSTA: a variable describing the metropolitan status of the respondent.

6. PTDTRACE: a variable describing the ethnicity of the respondent.
7. TEAGE: a variable describing the age of the respondent.
8. TESEX: a variable describing the gender of the respondent.
9. TUYEAR: a variable describing the year of the survey.

The second file is the ActivityFile lookup table. This has been transcribed in Excel from a PDF file provided by the Bureau of Labor Statistics [30] and converted to a CSV file, which we are using in our ETL process. The file contains 4 columns, a major category, a second-tier category, a 6-digit activity code and activity. The finest level of granularity is the 6-digit activity code with its corresponding activity. We joined the MainActivityFile with this file based on the 6-digit code, which gives us the name of the activity described in the data point. The columns with the major category and the second-tier category are much broader and function as groups of several different activities. To be able to join the activity code field with the MainActivityFile, we are adding a t in front of each 6-digit activity code.

The third file is the Ethnicity lookup table. This table has been transcribed from the lexicon of the different variables in Excel and then converted to a CSV file. The file contains an RaceID column as well as a category column, which describes each ID as a race. This table is joined with the MainActivityFile on the RaceID column.

3. Data Analytics and Visualization

For the visualization and subsequent analysis Tableau is used. The final dataset used for analysis has 2.459.524 rows, making it difficult for Tableau to handle. To make it easier to work with in Tableau, the final dataset was exported as a .hyper format file, a native file format for Tableau, allowing the dataset to run more efficient. Tableau's easy drag-and-drop features as well as its possibility to use trend lines makes it an attractive tool for this analysis. The version of Tableau used for both the graphs and the interactive dashboard is version 2021.2.

For an accurate analysis of the dataset, we created an extra column describing the age of the respondent. We are only interested in the trends within different age groups, and not at each age specifically. Therefore, we created four age categories to resemble the current generations: under 25, 25-45, 45-65, and over 65. Additionally, we created an extra column describing the date on which the data was collected. This variable was created by combining the YEAR and MONTH variable and by choosing the first of every month for the day.

We utilize several different filters for our analysis. First, for the activities, we use a filter for the major category, second tier category, and activity allowing us to filter on activities with different levels of detail. Secondly, we have a filter for the month and year. This is to be able to zoom in on different periods in time, allowing for a deeper dive into the data. Thirdly, we include a filter for the different age groups, allowing for comparisons between different generations. Lastly, we included filters on ethnicity and metropolitan status, allowing for a more specific analysis of the data, possibly leading to interesting results.

To visualize the data, we used line charts to plot developments over time. When plotting the variables, we looked at the time spent on each category in terms of the average time spent per person. We plotted the average number of hours spent doing the activity per day against time. We chose to use the Tableau 'AVERAGE' option for time spent because the data count varies per year. Because of this, merely using the 'SUM' option would lead to misleading results. Since the amount of time was measured in minutes, we divided this by 60 to find the time in hours.

4 RESULTS

Below the findings of each selected activity are presented and accompanied by a relevant visualization.

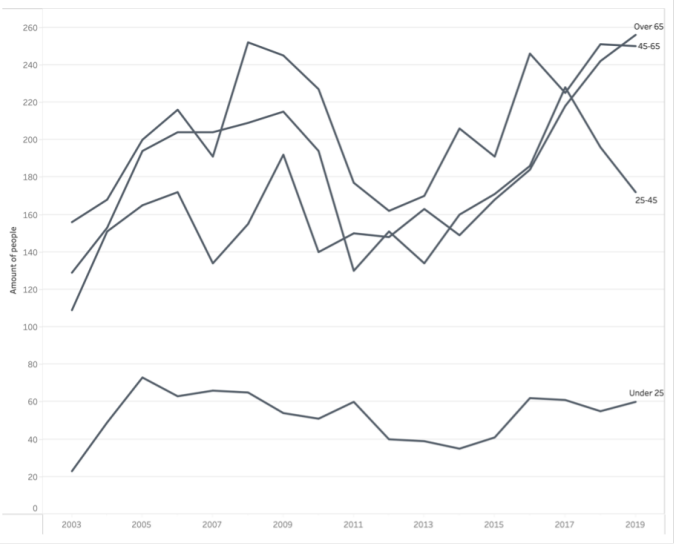

Figure 2. Number of people experiencing sleeplessness across different age groups.

Sleeping:

The amount of time respondents spend on sleeping has not shown any considerable changes throughout the information technology revolution of the 21st century. Between 2003 and 2019 there have not been any major fluctuations in the amount of sleep the average American got. There is merely a slight upward trend from 8.70 hours of sleep per day in 2003 to 8.83 hours per day in 2019, corresponding to a 1.4% increase, or 8 minutes more. This general trend holds for all age groups, except for the over 65 age group, which are experiencing a slight decrease of 1.1 %, or 6 minutes, in the amount of time they spend on sleeping. Another difference across age groups was that young people are getting considerably more hours of sleep compared to all other age groups for all years. The logic behind this is however straightforward, namely that adolescents simply need more sleep than adults.

While analyzing, we decided to include an analysis about the presence of sleeplessness in American society in this section. For this variable looked at the number of people reporting sleeplessness rather than looking at the average hours of sleeplessness experienced by the respondents. Figure 2 on page 4, shows that this has increased for all age groups, except for the under 25 age group. The increase has been largest for those aged over 65: from 110 people in 2003, to 255 people in 2019, indicating that the number of respondents experiencing sleeplessness has more than doubled.

In-person socialization:

In general, there has been a very slight decrease in face-to-face socialization over time, from 1.98 hours in 2003 to 1.93 in 2019, corresponding to a decrease of 2.4%, or a decrease of 3 minutes. Zooming in on the different age groups gives us similar results. The age groups 25-45 and 45-65 show slightly increasing trends, whilst the under 25 and over 65 age group show slightly increasing trends. We find that the age group that on average spends the most time socializing per day is the age group under 25 and the age group that on average spends the least time socializing per day is the age group 45-65. Figure 3 on page 5 shows the general trend per age group.

TV-use:

Americans have increased the average amount of hours spent watching television per day since 2003. In 2003, the average American spent 3.40 hours per day watching TV and in 2019 this has increased to 3.94

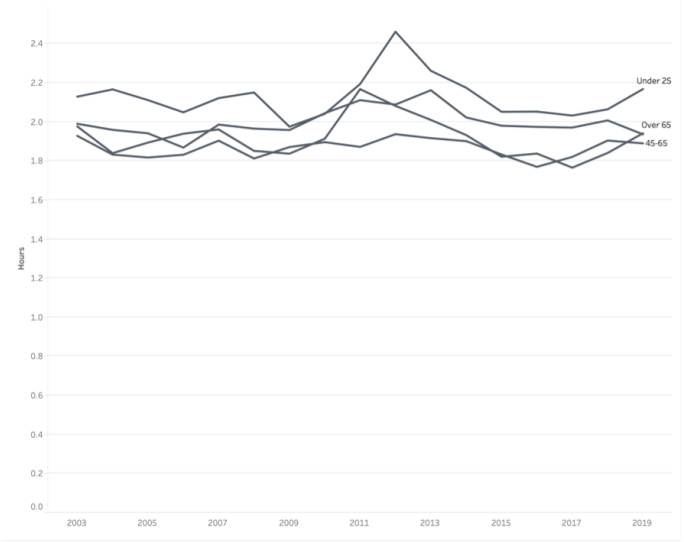

Figure 3. Average amount of hours spent on socializing across different age groups.

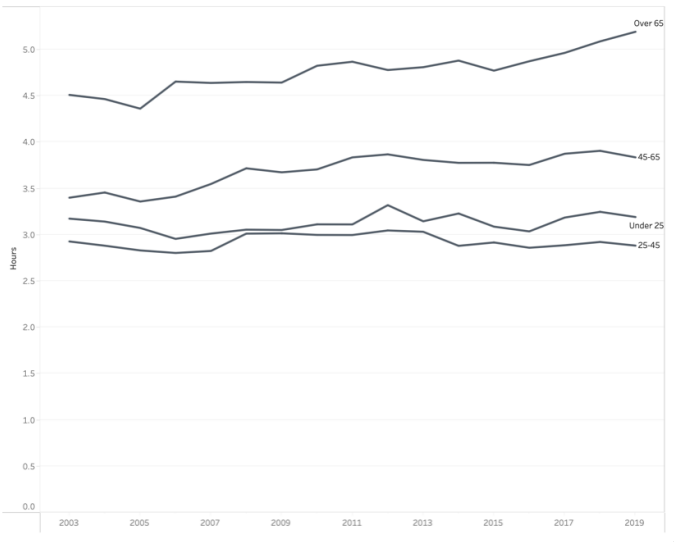

Figure 4. Average amount of hours spent on watching TV across different age groups.

hours, representing a 15.7% increase, or an increase of 30 minutes. Put differently, nowadays Americans are spending almost one sixth of their day on watching TV. Figure 4 on page 5 shows the trend across the different age groups. We find that the over 65 age group spends the most time watching television per day across all years, up to 5.22 hours per day in 2019. This is a big leap from the other age groups: 3.91 hours for age group 45-65, 2.92 hours for age group 25-45, and 3.20 for those aged under 25. For the age group 45-65 and over 65 the average number of hours have been increasing steadily from 2003-2019, an increase of 15.1% and 16.5% respectively. At the same time, the general trend for the age group 25-45 and under 25 appears more constant, a 1.5% decrease and 1.7% increase respectively. Therefore, it seems that the older generations have contributed most to the overall increase of TV consumption of 15.7%.

PC-use:

The amount of time spent on computer use for leisure has experienced a decrease since 2003. In 2003 the average American spent 1.58 hours on the computer, and in 2019 this was 1.32 hours, corresponding to a 16.4% decrease, or a decrease of almost 16 minutes. Filtering on age group, the data shows similar results, namely that computer usage is decreasing among all age groups. A limitation of the used variable is however that it does not include the amount of time people spend on playing computer games. In order to get insights on this, we had to look at another variable, the *playing games* variable. This variable includes playing board games, playing computer games, and hiding Easter eggs. Plotting this variable against time shows a considerable increase in time spent on playing games for the under 25 age group (Figure 5 on page 5). The age group below 25 spent an average of 2.26 hours per day playing games in 2003, and 2.75 hours in 2019, corresponding to an increase of 17.8%, or an increase of 30 minutes.

Sports and exercise:

There has been a considerable decline in the amount of time Americans spend exercising and working out. In 2003, the average American spent 1.44 hours exercising and this has decreased to 1.24 hours in 2019, corresponding to a 14.3% decrease, or an average decrease of 12 minutes. When observing the trends across different age groups (Figure 6 on page 6), we find the similar pattern for all age groups that they are spending a decreasing amount of time on sports and exercising.

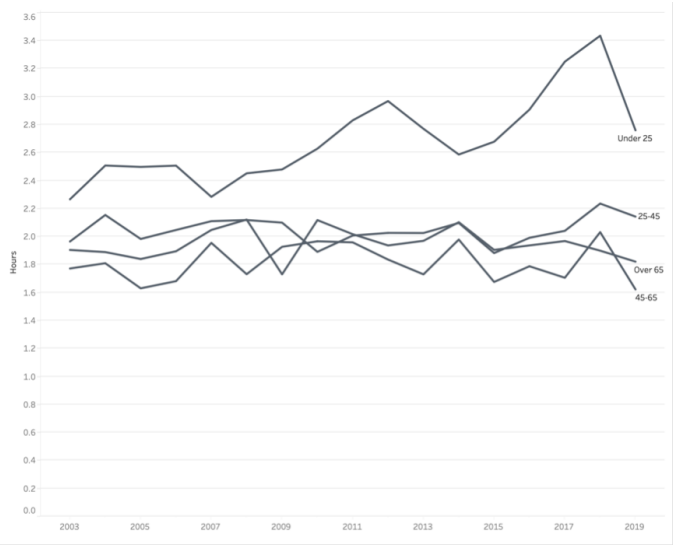

Figure 5. Average amount of hours spent on playing games across different age groups.

Zooming in on the different age groups, we find that the downward trends are the steepest for the age group below 25 and between 25 and 45. The age group 25-45 spent on average 1.51 hours per day on sports and exercise in 2003, while in 2019 this had number had fallen to 1.28, corresponding to a decrease of 15.2%, or a decrease of almost 14 minutes. The age group below 25 spent an average of 1.77 hours per day on sports and exercise in 2003, and in 2019 this number was 1.66, corresponding to a decrease of 6.2%, or a decrease of almost 7 minutes. We find that over the entire time span, the age group under 25 is on average spending the most hours per day doing sports and working out, and the over 65 age group spends on average the least number of hours per day pursuing sports and other workout related activities.

5 ACTIONABLE INSIGHTS

Below, we present actionable insights for the HHS. These insights are grouped into three categories: no actions required, potential actions

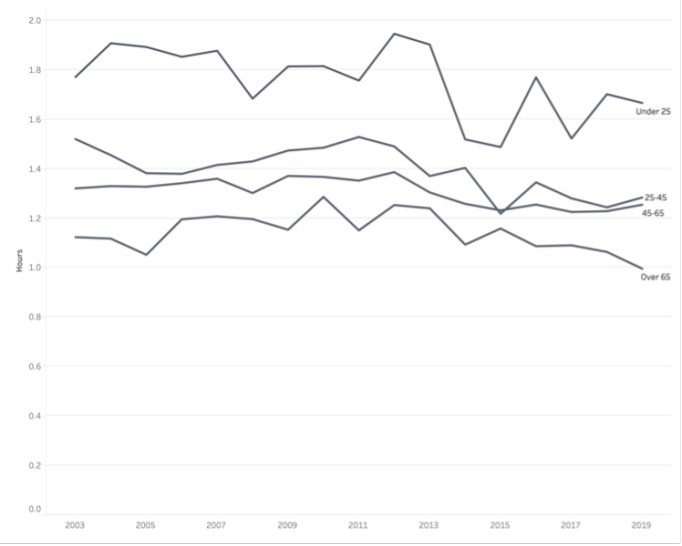

Figure 6. Average amount of hours spent on playing sports across different age groups.

required, and actions required. We will discuss each of the five activities by classifying them in the appropriate category.

No actions required

As seen in the previous section, for in-person socialization no noticeable insights were gathered. Social activities were fluctuating among the age groups with no clear trend, leading to us to conclude there is no direct link between digitalization and in-person socialization. Therefore, based on this data, we advise the HHS to not take any actions on promoting physical socialization or anything of the like.

Potential actions required

In general, we found no alarming trends for computer usage for leisure that would require immediate actions by the HHS. However, in the playing games category there is a possible alarming trend. Respondents in the age group under 25 have been considerably increasing their number of hours playing games, including computer games. It is however unclear whether this increase is due to playing games on the computer or not. We therefore advise the HHS to explore this data further and to investigate where this increase is coming from. If it ends up being the case that computer gaming has been increasing considerably, we advise the HHS to take action to promote a healthier balance with less time spent on the computer.

A second topic for potential action by the HHS considers sleep. Sleep is one of the most vital factors of well-being and health. Our results show that Americans are sleeping slightly more on average. All age groups except the over 65 age group have been experiencing upwards trends, which is a promising sign for the HHS as it does not seem that Americans are sleeping less due to digitalization. It must be noted however that the changes observed among the age groups are very minimal and only correspond to a change of a handful of minutes. Since our data merely describes the length of the sleep but does not include any information regarding sleep patterns, we suggest the HHS to conduct further research on these sleep patterns to get a more comprehensive view on how American society is sleeping and whether this is affected by digitalization. This advice stems from the observed increase in sleeplessness among the respondents of the ATUS. The number of people experiencing sleeplessness increased for all age groups except for those under 25. We are unsure what could be contributing to this increase, but it is clear it is not a healthy trend. Because of the many uncertainties in this topic, further research is advised to create clarity.

Actions required

As mentioned before, exercise and doing sports is of vital importance for overall well-being and health. Our findings show that all age groups are reducing the time they spend on pursuing sports and exercise throughout the years, especially the two youngest age groups. Currently, the average respondent is still spending more than the recommended 60 minutes of exercise per day by the World Health Organisation [31], however for both groups, most of the decrease has been taking place in the last decade, an alarming sign for the HHS. This could be contributed to the more digital lifestyle, but further research needs to be conducted on finding what the respondents did instead of exercising. In any case, we advise the HHS to start a campaign to keep Americans moving. A second topic where action is required is that of TV-use. Our findings show that TV consumption has been on the rise among 45–65-year-olds and over 65. Combined with the fact that these two age groups have been showing a decrease of sports and exercise while increasing their TV consumption, our recommendation is for HHS to conduct a campaign, promoting a more active lifestyle for the older people in American society.

6 DISCUSSION AND CONCLUSION

The aim of this paper is to formulate an answer to the research question *"Using ATUS data, how has the information technology revolution of the 21st century affected the way Americans spend their time?"*. In order to do so, this report discusses the impact on five key areas of daily life: sleeping, in-person socializing, watching TV, using computers, and exercising. Before putting together an answer to our research question, we review our hypotheses and conclude whether our data supports the hypotheses or not.

H1: Based on the data in this report, we infer that our hypothesis that sleep will have decreased is not supported. Our data suggests that in general all age groups in American society have been increasing the number of hours they sleep each day, except for the over 65 age group.

H2: Based on the data in this report we infer that our hypothesis that in-person socialization will have decreased is not supported by the data used. Our data suggests that time spent on face-to-face socializing has remained constant across all age groups between 2003 and 2019.

H3: Based on the data in this report we infer that our hypothesis that TV use will have increased is partly supported, since our data suggests that time spent on watching TV has increased for the older generations and remained constant for the younger generations. This difference may be attributed to the fact that younger generations use more and more different entertainment platforms, whilst older generations stick to the TV medium.

H4: Based on the data in this report we infer that our hypothesis that PC-use will have increased is not supported. Time spent on PC-use has not experienced any considerable upward or downward trends over time. The data did show considerable fluctuations which need further investigation, but the volatility did not lead to any breakouts and thus no trend was found.

H5: Based on the data in this report we infer that our hypothesis that time spent on sports will have decreased over time is supported by the data used. Time spent on exercising and working out has decreased across all age groups in American society.

Bringing it all together, it can be said that the composition of time spent on day-to-day activities in American society has changed over the past two decades. Time spent in front of the television has increased and Americans seem to be sleeping slightly more than before. Time spent on in-person social activities revealed no distinct trends with a rather consistent number of hours spent per day on socializing throughout the

years. At the same time, Americans are spending less time on sports and exercising, just as time spent on using the computer for leisure has decreased. This however does not include time spent on playing video games, which has potentially considerably increased for the youngest generation. Despite these interesting facts, it must be noted that we cannot deduce with certainty that these changes can be attributed to digitalization only. There may be external factors influencing time use that have not been addressed in this analysis. Nevertheless, we have decided on a few recommendations and trends to monitor over the coming years for the HHS.

Short term strategy

The short-term strategy for the HHS is driven by the problem or trend we found to be most alarming and in our opinion requires immediate attention. We found that TV consumption has been increasing considerably among 45-65 and over 65-year-olds. According to the data, these two age groups are simultaneously spending less time on sports and exercise for the past years. Our understanding is that this trend is critical and should be addressed by HHS. Additionally, the HHS should focus on promoting sports among adolescents. Exercising is vital to their health and development, but the trend of spending time is only going downwards. So, our recommendation is that HHS's immediate focus should lie on promoting exercising among the whole of American society.

Long term strategy

Besides our recommendation of immediate action, we advise the HHS to monitor several trends over the coming years. First, we believe sleeplessness should be observed. Since our findings are limited by the data, we cannot determine what is causing the increased number of people among the older age groups to experience sleeplessness. Hence, we suggest the HHS to follow the trend of this activity. Another aspect to keep track of is the activity of playing games among age group under 25. The trend showed a considerable increase every year in average number of hours playing games per day. Included in the variable are however three categories of playing games, whereas only one is related to digitalization: playing computer games. Therefore, we are not able to conclude that the increase is solely based on digitalization, and we advise the HHS to investigate this further. Lastly, it would be interesting for the HHS to dive into how developments in time use may differ across different ethnicities. This report does not cover it, but the information is included in the dashboard. This might reveal interesting insights in what ways ethical groups differ in terms of time spent of certain activities.

Dashboard

The interactive dashboard focuses on providing the user with the possibility of exploring the ATUS data themselves, and in conjunction with our report, allow them to dive deeper into the thematic of digitalization. The goal of the dashboard is to inform the user about the data and give them the ability to explore it by themselves. To ensure a high degree of interactivity we used the interactivity taxonomy framework proposed by Yi et al. [32].

The dashboard features the filters discussed in the methodology section and shows three graphs in total. The first graph shows the average time spent in hours of the given activity selected. The second and third graph show the average time spent in hours for men and women across the four different age categories. To represent the different activities, gender, and age categories in the graphics we selected a single colour and labelled the different lines, so we achieve W3C conformity, minimizing obstacles for colour blind people. Additionally, we created a user guide in the dashboard explaining what data is used for the dashboard and how users should engage with the dashboard. The dashboard has a phone, tablet, and desktop version and for each version we attempted to maximize the information available and minimize any obstacles, such as scrolling.

We decided to stick to the filters described in the methodology to avoid cluttering and an overload of filters, which could create room for confusion. There is however much more possible with the ATUS data than just the filters we decided to implement. Interesting variables to include would be a variable describing the labour force status of the respondents, a variable describing if the respondent works full-time or part-time and a variable describing the income of the respondent. Filtering on these values could give valuable insights in different behaviours and trends across people from different economic backgrounds, allowing for a more in-depth analysis.

Limitations

While reading our recommendations, the HHS must keep in mind that the goal of this report and accompanying dashboard was to create and analyse the data given the tools provided within the Visual Analytics class at Copenhagen Business School. Accordingly, we did not do any statistical analyses and therefore cannot conclude anything about the significance of our findings. An additional limitation of this research is the use of secondary data. Secondary data is not authentic and reliable, meaning that our findings would need a second study to validate them. On top of that, the definition of several activities changed over time in the ATUS survey. It is difficult to concentrate on a variable if its meaning changed from one year to another. Therefore, this study would again require a second study to validate the findings before acting upon any results. Lastly, we believe a limitation of the dataset itself that there is no data available on the geographical locations of the respondents. Being able to filter on location could provide more insights and make room for more complex visualizations.

7 LEARNING REFLECTIONS

With this project we learned how to study data in an End2End process where we first explored the data in Tableau, proceeded by cleaning and transforming the data in Alteryx, and finished off by creating a dashboard for high-level exploration of the data in Tableau, allowing for a detailed analysis of the data. This report gave us the chance to learn more about the process of preparing data for analyses and what kind of trade-offs one needs to make in the process. As such we needed to decide to limit our options for filtering and detailing to ensure that the dashboard performs well, and the user will not experience any problems when engaging with it. Moreover, we learned how to utilize the unique skills of each of the group members. Some were more skilled and interested in the ETL process whereas others wanted to learn more about creating engaging graphs, meaning we had to distribute the work tactically, while constantly stay in close contact with each other. These two points were the biggest learning achievements for us as a group.

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Throughout the process of creating the visualization of the American Time Use Survey we used the lecture material to decide which colours to use and how to effectively structure the ETL process. The data used was provided by the U.S. Bureau of Labor Statistics of the United States Department of Labor and was accompanied by valuable documentation of the data, including explanations of variables and conversion tables. Additionally, existing analytical reports covering the ATUS dataset inspired us on how to tackle the analysis, helped us to check whether our calculations were correct and that we did not make mistakes in the ETL process. Thus, we thank our lecturers for the provision of the learning material, external sources and guidance throughout the project, the United States Department of Labor for the provision of the data, and previous research for providing us with helpful reports.

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