Pocket Security:

Israeli Android Users' Smartphone Usage Before and During Israel's Second Covid-19 Lockdown

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Executive summary

Israel is one of the fastest growing smartphone markets worldwide. It is also a world leader in usage of smartphones for Internet browsing and networking. However, while smartphones offer effective and convenient Internet access, they also open new avenues for cyber-attackers and increase the potential risk of falling victim to cyber-attacks, such as SMS ranger, SMiShing, WhatsApp phishing, and malware. To generate insight into Israeli Android phone users' mobile usage and gauge the online risks they encounter when using their smartphones, the Evidence Based Cybersecurity Research group at Georgia State University and the Federmann Cyber Security Centre at the Hebrew University of Jerusalem launched the "Pocket Security among Israeli Smartphone Users" project in 2020. This research project was supported by the Israel National Cyber Directorate (grant #3011004036). To collect data from a sample of 156 Israeli Android smartphone users, aged 18-56, we employed the Mobile Application Data CAPture (MADCAP) application, which was designed to collect and analyze data from mobile devices. This first report presents findings from our preliminary analyses.

Key findings:

Average number of smartphone applications used:

- Israeli Android users use on average 5.39 applications throughout the day.
- The hourly average trend of applications usage suggests a constant increase in application use starting at 7am, a peak at 8pm, and then a constant decline, with the lowest number of average apps used at 4am.

Most popular apps:

- WhatsApp was the most used application among Israeli Android users, followed by Gmail, Instagram, and Twitter.
- 18-21 years old mostly use social media apps.
- Across all educational levels, Gmail is the second most-used app.

Pre-lockdown vs. lockdown mobile phone usage:

- Significant variation in the number of apps used hourly during the lockdown period, with a peak of 11 apps at 2pm.
- A significant decrease in app usage before and during lockdown for single users, but a significant increase in app usage for married users.
- A significant increase in the number of apps used by conservative participants from pre-lockdown to lockdown.
- Increased use of email and social media during lockdown.

Introduction

Israel is one of the fastest growing smartphone markets worldwide and a world leader in usage of smartphones for Internet browsing and networking (Google, 2013). According to recent estimates, more than 6.5 million Israelis own a smartphone (Statista, 2020). The average age of smartphone owners in Israel is 10 years old, with an average usage time of 4 hours a day (Bezeq, 2019). Market data indicate that about 77.56% of the Israeli smartphone users use smartphones with an Android operating system (Statacounter GlobalStats, 2021) and use them for a wide range of online activities, including shopping, getting news updates, and keeping in touch with their friends. Unfortunately, although the proliferation of smartphones enables nearly ubiquitous internet access, it also increases users' exposure to various types of cybercrime, such as phishing attacks (Felt et al., 2011; Norton by Symantec, 2012), cross-site scripting (Purviance, 2011), sniffing (Wu et al., 2007), and viruses (Kapersky Lab, 2009).

For example, users could access an unsafe website on their phone due to a distraction in the environment, access a bank account on open Wi-Fi in a crowded coffee shop, open a malicious email allegedly from a friend, or simply leave a smartphone unattended on a table, allowing a thief to read sensitive government email. All of these cyber-crimes are made possible by the interaction of mobile devices and the physical world. Indeed, extensive research has focused on technical solutions for detecting and preventing mobile cyber-attacks (e.g., Becher et al., 2011) and on how users respond to security and privacy warnings (e.g., Egelman et al., 2008). However, extant research has not evaluated the interaction of social context, personal online habit, and individual psychology on susceptibility to cybercrime realized through mobile devices. In order to bridge this empirical gap, the goal of this research project is to identify social and personal factors that influence Israeli smartphone users' interactions with their smartphone devices and their susceptibility to cybercrime victimization. Our first report from this project seeks to highlight typical Israeli Android users' habits with their phones during the year 2020.

Overview of research methods

To collect data and meet our research goals, The Evidence-Based Cyber-Security Research Group and The Federmann Cyber Security Center employed the Mobile Application Data CAPture (MADCAP) app to collect data from Israeli Android users' smartphones during 2020. MADCAP was developed for the open-source Android mobile platform, with the goal of collecting and analyzing data from mobile devices (International Data Corporation, 2015; Shepard et al., 2011). The MADCAP platform is comprised of two main components: 1) an Android application deployed to capture smartphone activity and location, and 2) a secure web analysis platform for collating, querying, and analyzing the data by transforming the raw sensor data into a timeline of events and augmenting the data with the semantic information necessary to support behavioral analysis.

Study participants were recruited using online advertisements posted on The Federmann Cyber Security Center webpage, as well as on social media platforms like Facebook and Twitter.

After consenting to participate in the study, participants completed a questionnaire and were asked to download and install MADCAP on their Android devices. Once installed, MADCAP collected all the information available on the smartphone including processes, telecommunication events, GPS location, and application usage. Our final sample includes 156 Android smartphone users whose smartphone activity was monitored for a two-month period between June and September 2021.

Results

Sample Characteristics

Table 1 presents the demographics characteristics of our sample. As may be observed in the table, the subjects' ages ranged from 18 to 56 years old, yet the dominant age group was below the age of 30 (63.6%).

Over half of the study participants were male (59.4%). Close to 60% of the study participants were single, with 35.1% married and 5.2% divorced. Approximately 87% were born in Israel (SABRA) and 13% were born abroad. In line with the socio-demographic structure of Israel, 66.9% of the participants identified themselves as secular and 33.1% had conservative religious views.

Most of the participants are BA degree graduates (45.1%), followed by high school graduates (30.1%), Master's degree graduates (18%), professional certificate holders (3.8%), and Ph.D. graduates (3%).

Moreover, many of the participants self-reported that their income was far below average (36.1%). This category was followed by below average income (30.1%), above average income (18.8%), average income (10.5%), and far above average income (4.5%). Concerning cyber-security, most of our sample had not received information security training (68.4%).

Table 1 sample characteristics

	%
GENDER	
Male	59.4%
Female	40.6%
AGE GROUP	
18-21	8.3%
22-29	55.3%
30-39	19.7%
40-49	11.4%
50+	5.3%
EDUCATION	
High School	31.1%
Professional certificate	3.8%
BA	45.1%
MA	18%
PHD	3%
RELIGIOSITY	
Secular	66.9%
Conservative	33.1%
MARITAL STATUS	
Single	59.7%
Married	35.1%
Divorced	5.2%
INCOME	
Far below average	36.1%
Below average	30.1%
Average	10.5%
Above average	18.8%
Far above average	4.5%
ORIGIN	
Israel	87%
Other countries	13%
INFORMATION SECURITY TRAINING	
Yes	31.6%
No	68.4%

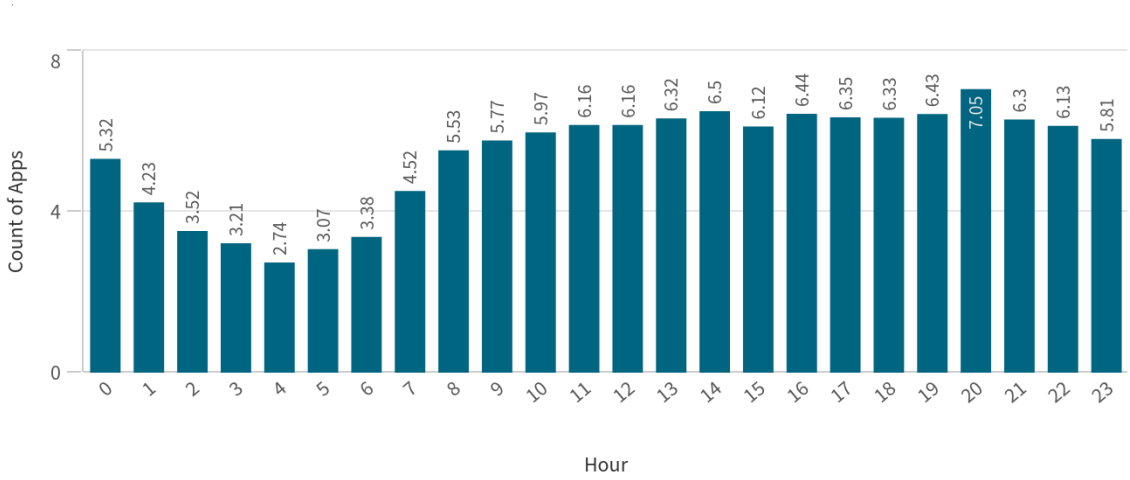
Typical Android Users' Smartphone Usage

The data collected by MADCAP from our study participants' smartphones was extensive. Specifically, it included detailed information about the type of applications used by the subject, their geographical location, and the time of use. To allow a thorough and meaningful understanding of Android users' smartphone habits, we aggregated the smartphone data we collected through MADCAP into ten-minute intervals.

Android application usage throughout the day

The distribution of the average number of apps used throughout the day shows that more apps were used during the day than at night. As Figure 1 shows, the average number of apps was highest at 8 pm (7.05). At this time of day, many Israelis have recently finished their workday and have some time to relax, perhaps by sitting on the sofa with their phones.

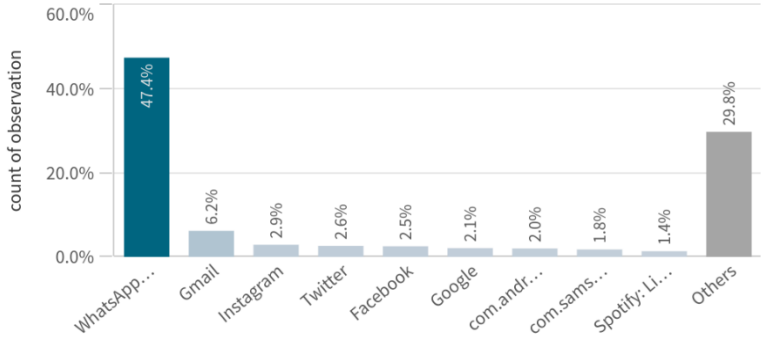
*Figure 1. Distribution of Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval Across Hours of the Day Throughout the Data Collection Period (two months) **



Most used applications

Evaluation of the application usage pattern indicates that WhatsApp is the most prominent app used in our sample. With Instant Messaging (IM) being the most prominent application among our sample, it is evident that large parts of social life and interactions are continuously moving online (Thulin, 2017). WhatsApp is the IM application of choice for these users, congruent with statistics indicating that in 2013, WhatsApp had more active users worldwide than Twitter (Lupton, 2015). The increased WhatsApp use may be due to the privacy the app offers: rather than having conversations in public, users can chat and share files (e.g., images and documents) only with individuals they want to communicate with. WhatsApp usage was followed by Gmail, Instagram, Twitter, Facebook, and Google, to round out the top six apps. All those applications promote social and work lives; for example, emails may be utilized for personal and work-related communication. Likewise, individuals may use social media for self-expression, entertainment, communication, and work (Lupton, 2015). New job roles have emerged out of social media in recent years, such as content manager, social media and digital marketing, and social media designer.

*Figure 2. Distribution of Average Open (Foreground and Background) Smartphone Applications per Ten Minutes Throughout the Data Collection Period (two months) **

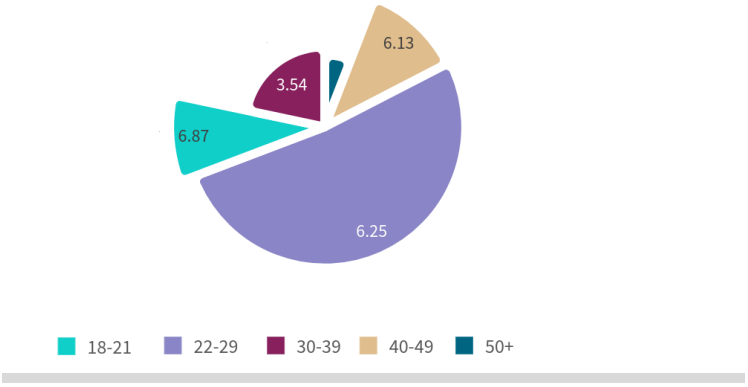


Demographic comparisons of application usage

Age group comparison

Our data reveal that the average number of applications used (measured in ten-minute intervals) across different age groups ranges from 3.19 to 6.87. Figure 1 shows that the 18–21 age group has the highest number of apps used on average, 6.87. No significant differences can be observed between the 22–29 and 40–49 age groups with averages of 6.25 and 6.13, respectively. Interestingly, the age groups 30–39 (3.54) and 50+ (3.19) have a similar level of app usage. Youths' (18-21 years of age) increased app usage is not surprising, as they are digital 'natives' who were born and raised surrounded by technology. Similarly, participants over age 50 may use fewer apps because they are 'technology migrants.' They were introduced to technology later in their life and therefore had to adapt to smartphones and other information communication technology (Ballano et al., 2014).

*Figure 3. Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval for Different Age Groups Throughout the Data Collection Period (two months) **



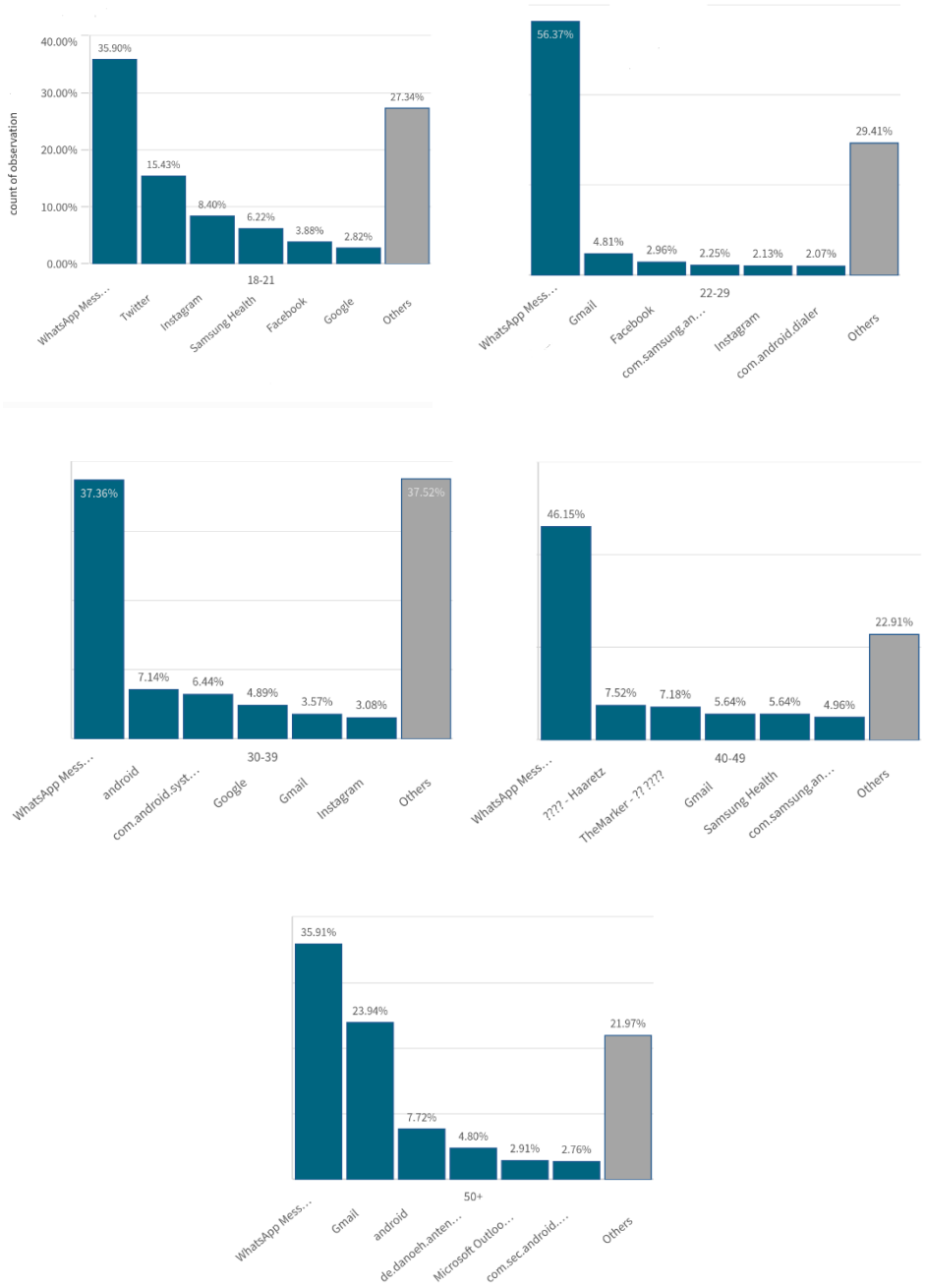
*The length of the radius indicates the average number of apps used by each group per 10-minute interval. Portion sizes display the percentages of people who have the corresponding age in the sample.

Remarkably, however, our analysis indicates that people in the age group 40–49 used almost twice the average number of apps than the 30–39 age group, even though our sample had more participants in the 30–39 group. This may be because the 30–39 group tends to have young children that they have to care for, whereas the 40–49 group likely has more self-sufficient teenagers, allowing them to spend more time on their phones. A small-

scope study from the United States found that young caregivers did not adapt to technology as quickly and tended to use technology and social media less (Bobkowski & Smith, 2013).

Inspecting the usage pattern across age groups shows that overall WhatsApp was dominant, with the highest percentage of users in the 22–29 age group. This is followed by various apps with usage patterns varying across age groups. For instance, youth (18–21) mainly used social media apps (i.e., Twitter, Instagram). These findings are in line with previous studies showing that youth are the most prominent users of communication technology, especially for instant messaging, social networking, and leisure activities (Jones & Fox, 2009). The second most used app for the age group 22–29 is Gmail, followed by Facebook. The age group 30–39 mainly used their mobile phone's system features and Google, while 40–49 used many news applications (i.e., Haaretz, The Marker). Interestingly, like the 22–29 age group, 50+ used Gmail, followed by the mobile system features.

*Figure 4. The Proportion of Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval within Age Groups Throughout the Data Collection Period (two months) **

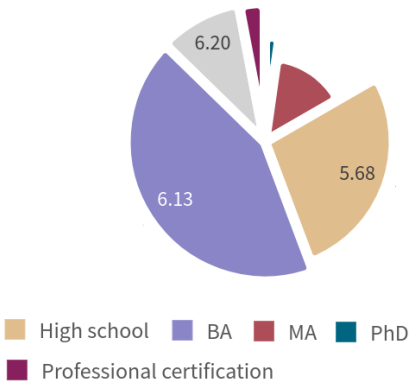


Education level comparison

Tracking smartphone application usage across different educational levels shows an interesting pattern that is only somewhat similar to previous studies (see Van Deursen & Van Dijk, 2014; Van Deursen et al., 2015). Bachelor's degree holders used the highest number of applications (see Figure 5), followed by individuals with professional certifications (6.11), even though only 3.8% of our sample fell into this category. Interestingly, Master's degree holders used the lowest average number of apps (3.76). Previous using cross-sectional methods to examine smartphone and Internet usage found that in some developed countries, people with low education spend more time on the internet than people with higher education (Van Dijk & Van Deursen, 2014).

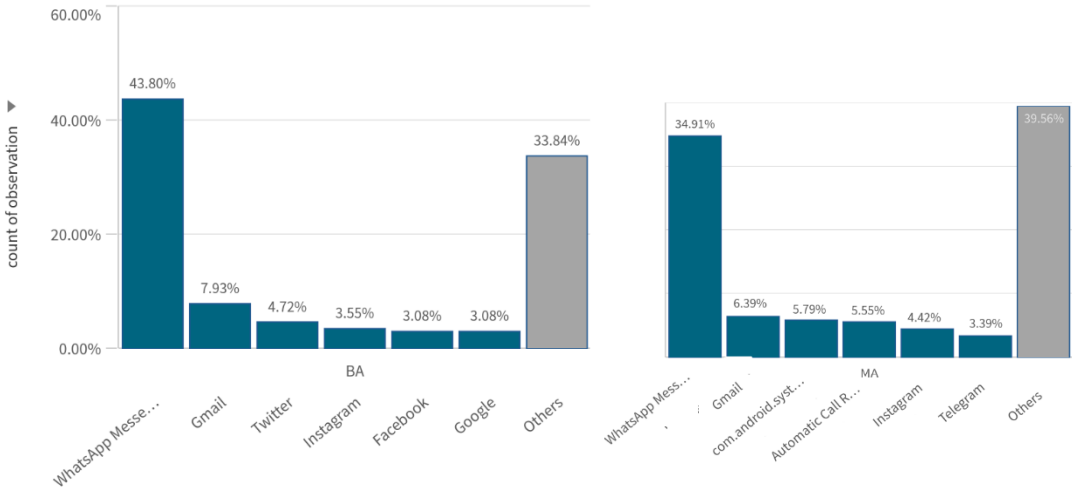
While our analysis indicates that less educated people used more apps per ten-minute interval, people with a Ph.D. used more apps than the MA educational level. Examining the apps used by different educational levels shows that WhatsApp is the most used app across all educational levels, followed by Gmail. However, the lower educational levels (high school and BA) were dominated by social media apps. This distribution is consistent with previous findings that there are gaps in app usage across people with high and low educational levels, who tend to use the internet and smartphone for different purposes. Previous studies also observed that people with lower educational levels engage more in social interactions and entertainment (Van Deursen & Van Dijk, 2014). Unlike these studies, we did not observe that more educated users tended to use their mobile phone and the internet for educational purposes and information seeking.

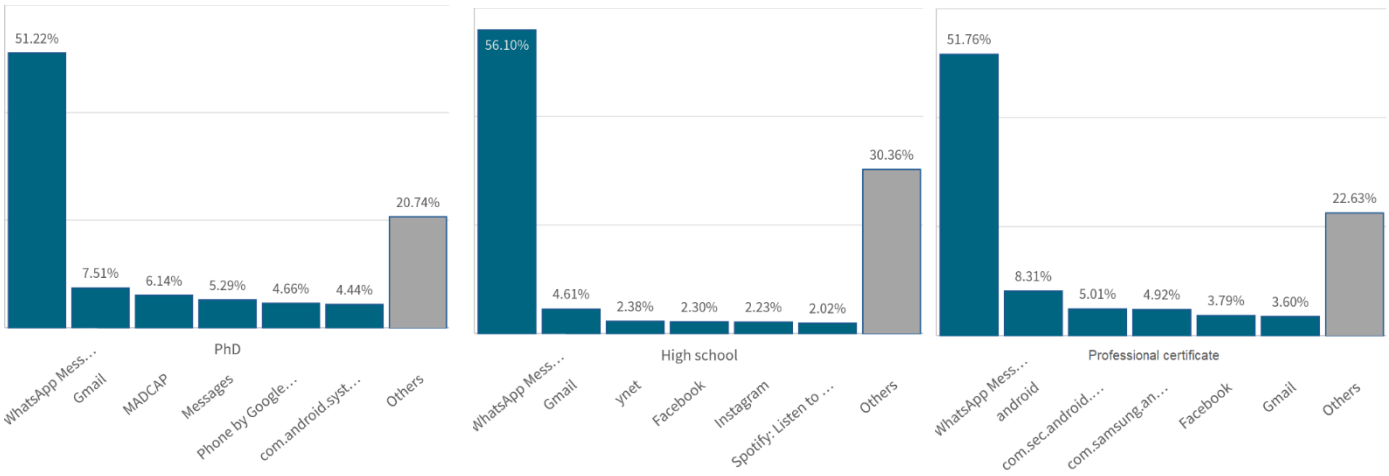
*Figure 5. Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval for Different Educational Status Throughout the Data Collection Period (two months) **



*The length of the radius indicates the average number of apps used by each group per 10 minutes interval. Portion sizes display the percentages of people who have the corresponding degree in the sample.

*Figure 6. The Proportion of Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval within Educational Statuses Throughout the Data Collection Period (two months) **

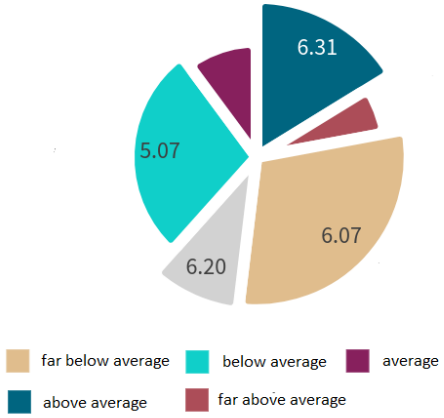




Income level evaluation

Interestingly, our analysis of smartphone application usage across income levels indicates that the highest number of apps are used by the above-average[1] income group (6.31), followed by the far below-average income level group (6.07). Previous studies that discuss the Internet and smartphone usage gaps relate this increased frequency of usage of two opposing income groups to the distinct purpose of this technology. The authors argued that people with high income utilize the Internet and smartphones for 'capital-enhancing activities'(Hargittai & Hinnant, 2008; DiMaggio et al., 2004), while people with low income employ the Internet and mobile applications in a more superficial manner, mainly communication and entertainment (Hargittai & Hinnant, 2008; Zillen & Hargittai, 2009).

*Figure 7. Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval for Different Income Group Throughout the Data Collection Period (two months) **

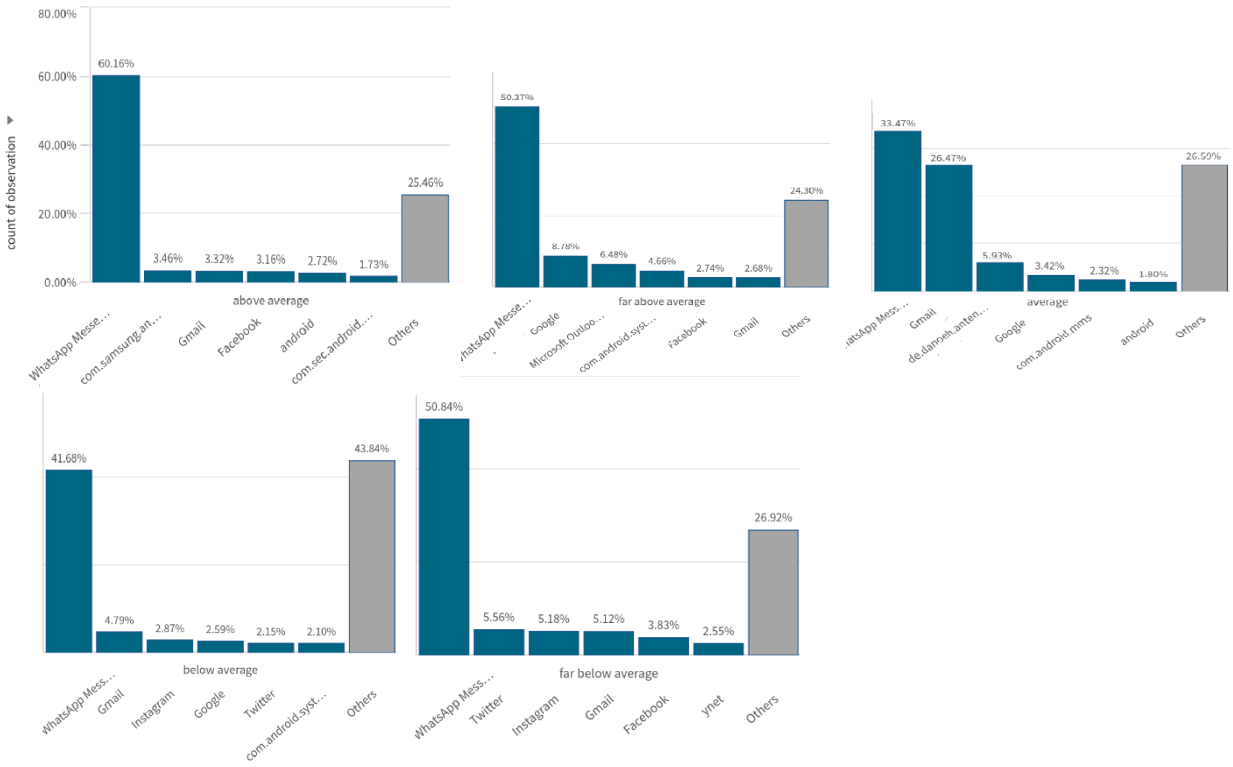


Indeed, Figure 8 illustrates that while participants of all income levels used WhatsApp the most, the other apps used were diversified based on income levels. People from the above-average income group tended to use smartphone SMS and Gmail applications, which can be viewed as career- and work-related, whereas the far below-average income group tended to pursue social interactions, entrainment, and gaming (Van Dijk, 2017).

[1] This is despite this group representing a relatively small portion of our sample.

Similar trends may be observed between the average income and below-average income groups, with the average income group using more Gmail and Google apps, which are often associated with capital enhancement. The below-average group used Gmail and social media apps.

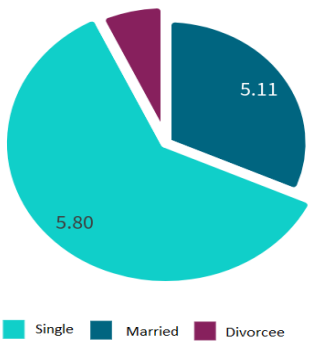
*Figure 8. The Proportion of Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval within Income Groups Throughout the Data Collection Period (two months) **



Marital status

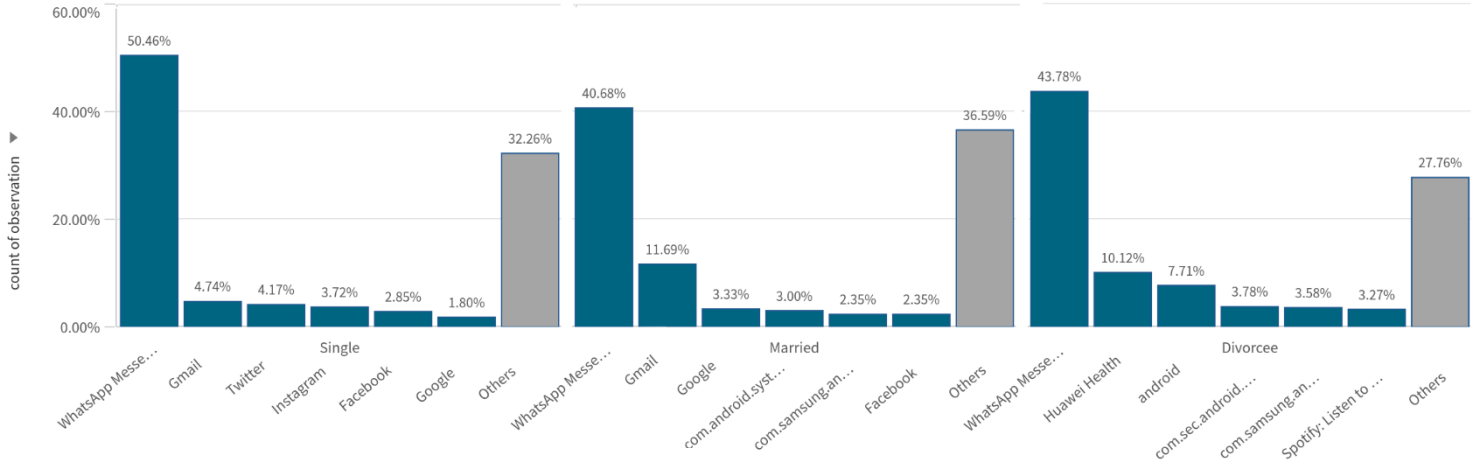
Examining the smartphone application usage of participants with different marital statuses shows that there are no significant differences in the number of apps used between single, married, and divorced people. Nevertheless, we observed that single people used the highest number of apps (5.80), followed by divorced (5.68) and married (5.11) people. This is in line with previous studies that found that unmarried individuals tend to use their mobile phones more often than married people (Rashid et al., 2020).

*Figure 9. Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval for Different Marital Statuses Throughout the Data Collection Period (two months) **



According to Figure 10, WhatsApp is the most used application for married and unmarried individuals, with the highest usage per 10-minute interval observed among single people. Interestingly, health applications were the second most-used apps for divorced individuals, whereas for single and married individuals, Gmail was the second most-used application. Previous studies observed that unmarried people tend to use mobile phones to access different tools (e.g., calculator, camera, calendar), music, email, and videos, whereas married individuals use web browsers, social apps, picture viewers, and lastly, tools. Our analysis indicates increased social media usage among single people, not married people.

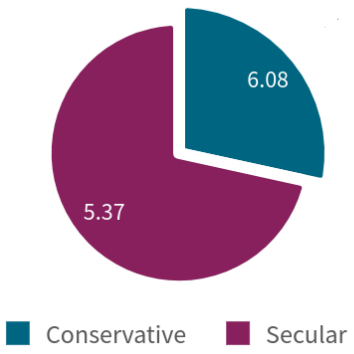
*Figure 10. The Proportion of Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval in Marital Status Groups Throughout the Data Collection Period (two months) **



Religiosity

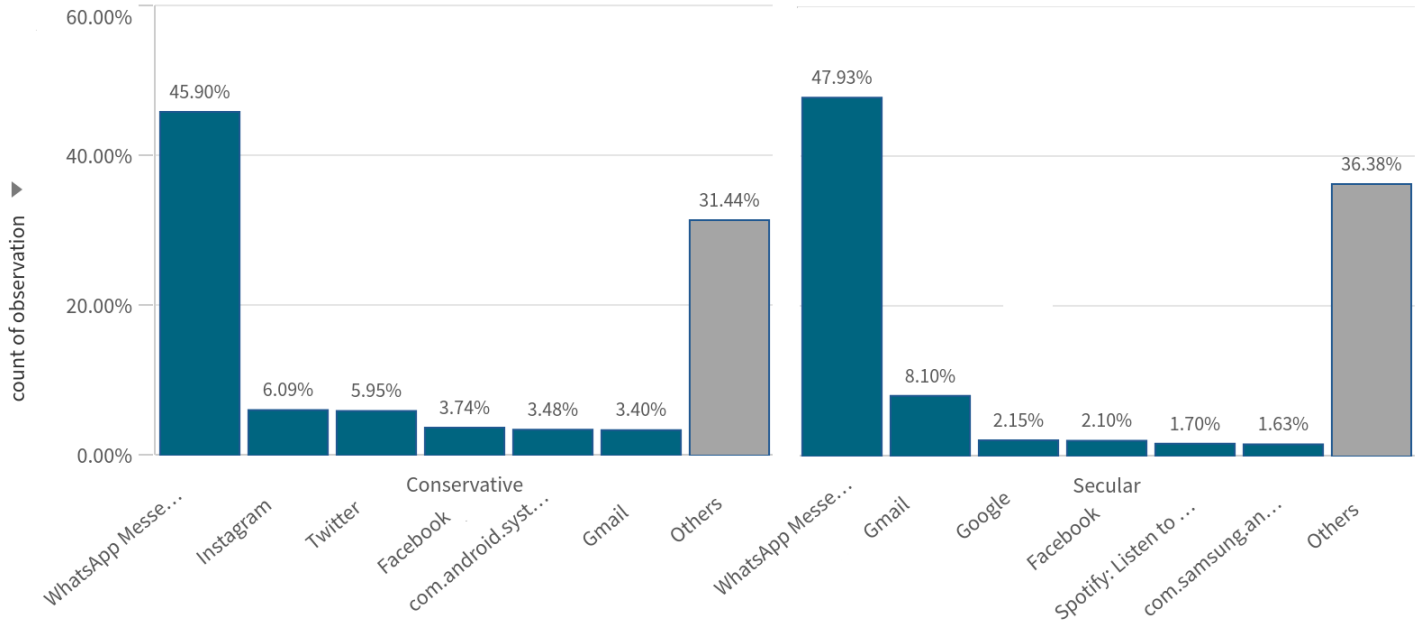
Our assessment of the average number of apps used by those with conservative and secular religiosity orientations shows that conservatives use, on average, slightly more smartphone applications (6.08) than secular users (5.37). These findings are surprising because a 2015 study reported that conservative people in Israel reject technology and the Internet and perceive it as an evil thing (Rosenberg & Rashi, 2015). It appears that the proliferation of smartphone devices in society has influenced religious practices (Bellar et al., 2018).

*Figure 11. Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval for Religiosity Groups Throughout the Data Collection Period (two months) **



In terms of the type of apps used by conservative and secular users, WhatsApp is the most used app by both groups. Interestingly, however, Figure 12 shows that for conservatives, the second most-popular choice is social media apps (i.e., Instagram, Twitter, Facebook). Seculars prefer Gmail, followed by Google and Facebook.

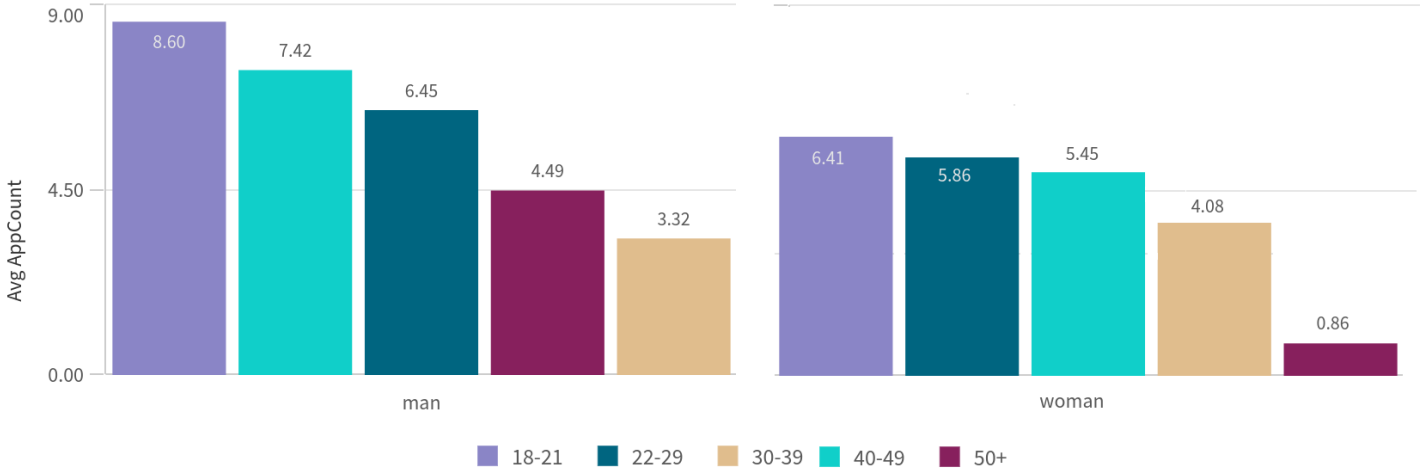
*Figure 12. The Proportion of Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval within Religiosity Groups Throughout the Data Collection Period (two months) **



Gender differences

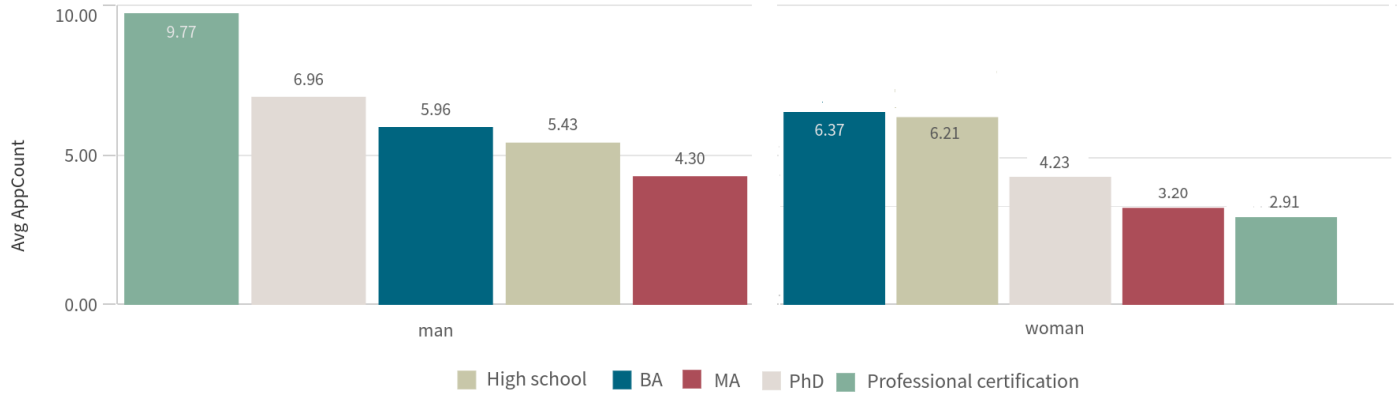
Examining gender differences in application usage showed no significant differences between male and female users, with males using average 5.64 apps and females 5.48. This is similar to previous studies showing that technology access gaps between male and female users have been diminishing (Ewing & Thomas, 2010; Losh, 2009; Van Deursen & Van Dijk, 2014). However, other socio-demographic characteristics may explain the remaining gap. When we evaluate the average number of applications used by males and females between different age groups, we find that both women and men 18–21 years old use an increasing number of apps. However, male youth (18–21) use on average more apps (8.30) than female youth (6.41). The increased number of apps used by male and female youth is not surprising given their generational exposure to technology (Jones & Fox, 2009; Perrin, 2015). Despite the overall insignificant differences between men and women, when comparing gender and age, men of all age groups use more apps than women (see Figure 13). The differences between males and females in the 50+ age group is noteworthy, with men using on average 4.49 apps and women using, on average, only one app (0.89). This may relate to generational gender gaps rather than gender gaps. Another evident difference is in the average number of apps used by women and men aged 30–39, with females using on average more apps (4.08) than males (3.32).

*Figure 13. Distribution of Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval Across Gender and Age groups Throughout the Data Collection Period (two months) **



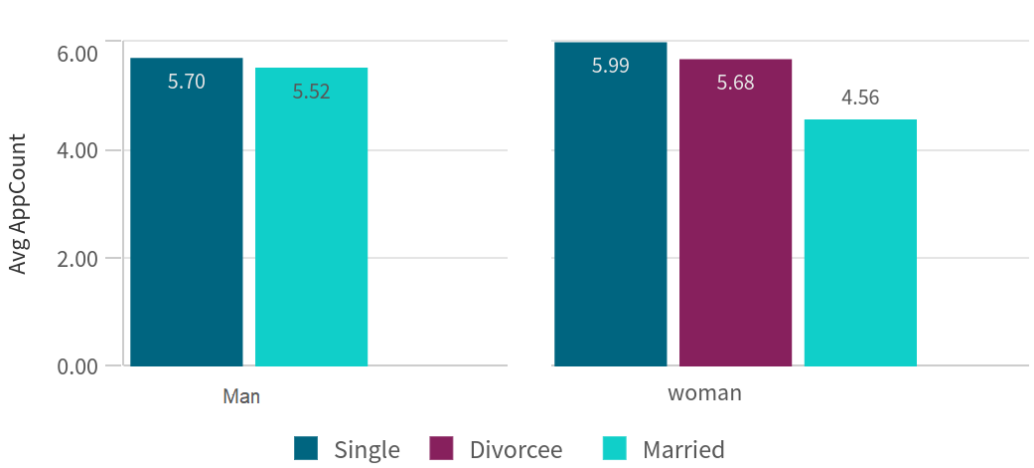
Inspection of application usage difference by gender and educational level shows that there are no significant differences in application usage between women and men who hold high school certificates, Bachelor's degrees, and Master's degrees. Both men and women in each educational level have a similar average number of app usage. However, men with PhDs and professional certifications use more app than their female counterparts.

*Figure 14. Distribution of Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval Across Gender and Educational Statuses Throughout the Data Collection Period (two months) **



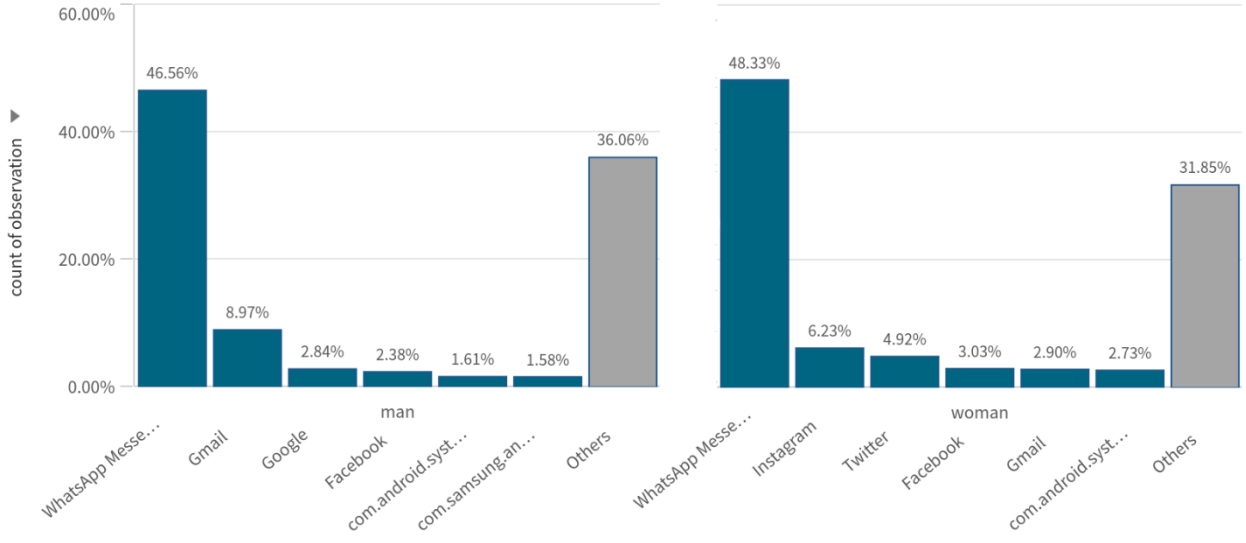
Finally, we reviewed the distribution of app usage by gender and marital status. Figure 15 demonstrates that both single men and women used the highest average number of apps. However, single women used a higher number of apps on average than men. In comparison, married men used on average more apps than their female counterparts. These differences may be related to caregiving differences, with women in Israel being more likely to have caregiving responsibilities.

*Figure 15. Distribution of Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval Across Gender and Marital Status Throughout the Data Collection Period (two months) **



Although overall, men and women use a similar average number of applications, Figure 16 shows that they utilize different applicational features (Van Dijk & Van Deursen, 2014; Zillien & Hargittai, 2009). Following WhatsApp, which is the most prominent app for both men and women, we note that men tended to use more e-mail and information-seeking engines, whereas women tended to use social media. Previous studies support these findings, showing that gender influences Internet and mobile activities, with women using mobile phones and the Internet for communication and socialization (Madden & Zickuhr, 2011; Kennedy et al., 2011). Men are using mobile phones and the Internet for work and information (Van Dijk & Van Deursen, 2013).

*Figure 16. The Proportion of Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval within Gender Groups Throughout the Data Collection Period (two months) **



Differences in Smartphone Usage Pre-Lockdown and During Lockdown

Background

The first case of COVID-19 in Israel was identified on February 21, 2020. Following a rapid spread and increases in the number of infected people, on March 15, 2020, the Israeli government announced its first lockdown. That lockdown ended on April 19, 2020, after a sustained decrease in the number of infected people. During the lockdown the Israeli population was not allowed to leave their households or meet with other people outside of their immediate circles, and many companies either shut their doors or introduced remote working. The second wave of COVID-19 infections emerged at the end of August 2020, resulting in a second lockdown that began on September 13 and was eased on October 17.

The 'pocket security' project commenced in May 2020, between the two waves of COVID-19 in Israel, and was finalized in mid-September, 5 days into the second lockdown. Our comparative analysis is a unique case study for several reasons. First, this is the first study that captured everyday smartphone usage data over a long period of time. Second, this data allows comparisons between everyday usage and emergency-time smartphone usage. Lastly, it reflects the uniqueness of Israeli society, which combines typical features of developed countries with those of more traditional societies. Specifically, Israeli society is characterized by unique family and social bonds, as well as a fascination with innovative technology.

The following section analyzes smartphone usage for 30 Israeli Android users for a five-day period before and during the second lockdown. Each user's smartphone activities were collected using MADCAP, an Android application deployed to capture smartphone activity and location. The initial sample consisted of 156 Israeli Android users, but a subsample of 30 users was chosen for two reasons. First, the lockdown period took place towards the end of the research period after we had experienced several dropouts. Second, we included only users for whom we had valid data from both before and during the lockdown periods.

The data collected by MADCAP from our study participants smartphones was extensive, including detailed information about the type of application used by the subject, their geographical location, and the time of use. To allow a thorough and meaningful understanding of Android users' smartphone habits, we aggregated the smartphone data we collected through MADCAP into ten-minute intervals.

Sample Characteristics

This section compares pre-lockdown and lockdown smartphone usage for a sample of 30 Android mobile phone users. The data analyzed in this section is from a week before lockdown (pre-lockdown) and the first week of the second lockdown in Israel. All the participants in this sub-group are between the ages of 22 and 39, with most participants (79.2%) between the ages of 22 and 29.

More than half of the sub-sample was male (60%) and single (72%). Of the 30 participants, 83.3% were born in Israel (SABRA) and 16.7 percent were born abroad. About half of the sub-sample is secular (56%) and 44% are conservatives.

Moreover, the majority of the sample are high school graduates (52%), followed by Bachelor's degree holders (32%) and Master's degree holders (12%). Approximately half of the participants self-reported their income level as far below average (52%), followed by below average (20%) and above-average (16%).

In the next section, we first present average app counts, broken down by different socio-demographic characteristics, followed by a representation of application usage percentage for the entire observed period (5 days before lockdown and 5 days of lockdown) in ten-minute intervals.

Table 2 sample characteristics

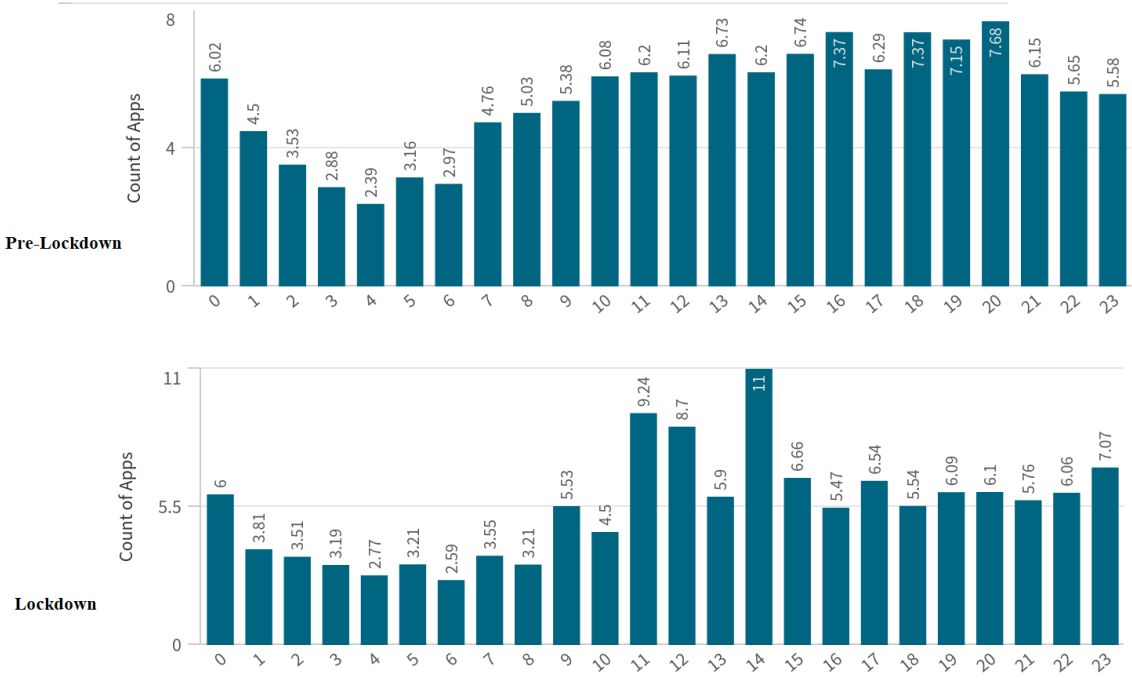
	%
GENDER	
Male	60 %
Female	40 %
AGE GROUP	
22-29	79.2 %
30-39	20.8 %
EDUCATION	
High School	52 %
BA	32 %
MA	12 %
PHD	4 %
RELIGIOSITY	
Secular	56 %
Conservative	44 %
MARITAL STATUS	
Single	72 %
Married	24 %
Divorced	4 %
INCOME	
Far below average	52 %
Below average	20 %
Average	4 %
Above average	16 %
Far above average	8 %
ORIGIN	
Israel	83.3 %
Other countries	16.7 %
INFORMATION SECURITY TRAINING	
Yes	28 %
No	72%

Results

Android applications usage throughout the day

Figure 17 presents the distribution of hourly average app counts in ten-minute intervals before and during lockdown. We can note that in the pre-lockdown period, smartphone usage was consistent throughout the day with an average of 6 apps during daytime. However, in the lockdown period we observed drastic fluctuations in app usage throughout the daytime, with peaks at 11-12 am and at 2pm.

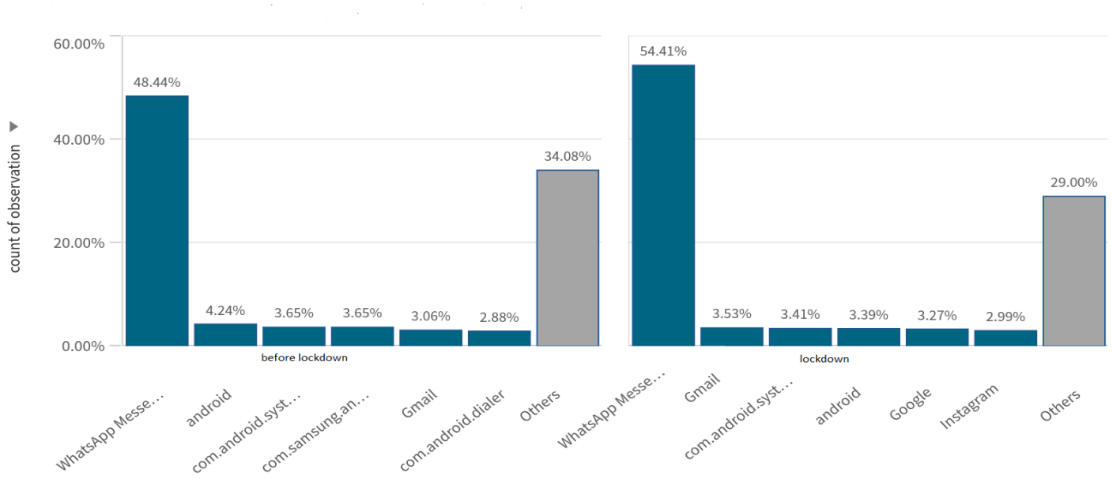
Figure 17. Distribution of Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval Across Hours of the Day for Pre-lockdown and Lockdown Periods.



Most used applications

Several different applications were used more often in each period. Before lockdown, the participants used WhatsApp, Android system, SMS services, Gmail, and Phone dialer, respectively. During lockdown, they used WhatsApp, Gmail, Android, SMS, Google, and Instagram.

Figure 18. Distribution of Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval for Pre-lockdown and Lockdown Periods.

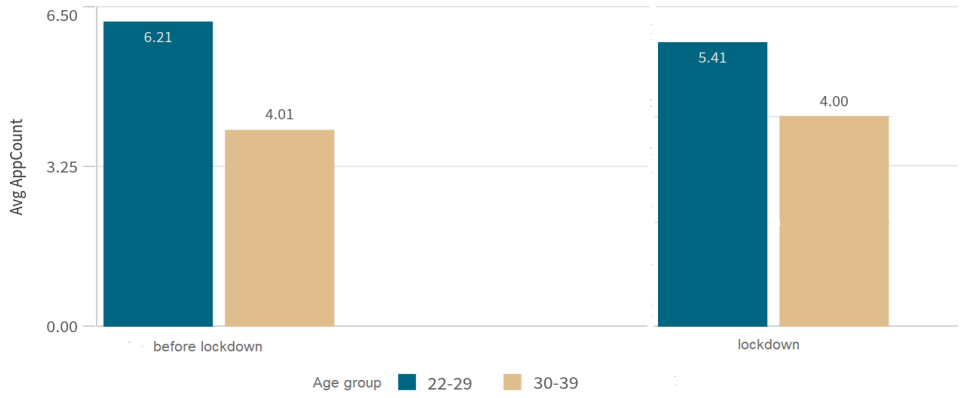


We can also note from Figure 18 that WhatsApp is the most popular app in our sample and that the number of observations for WhatsApp usage increased significantly from pre-lockdown period to lockdown period, going from 15% to 36%. This trend may be expected as people tried to maintain contact with their social circles, families, co-workers, or peers. We also note a slight increase in Gmail usage and the appearance of social media apps (Instagram) during lockdown. These changes in app usage may reflect individuals' attempts to maintain everyday life routines and a social life despite the pandemic.

Age

Comparing the average number of smartphone apps used before and during lockdown across age groups shows that the differences between age groups remain stable. Participants from 22–29 years old used on average more apps than those 30–39 years old, before and during lockdown. Interestingly, however, the number of apps used by the 22–29 group decreased from the pre-lockdown period to the lockdown period, from 6.21 to 5.41.

Figure 19. Comparison of the Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval in Pre-Lockdown and Lockdown, by Age Groups

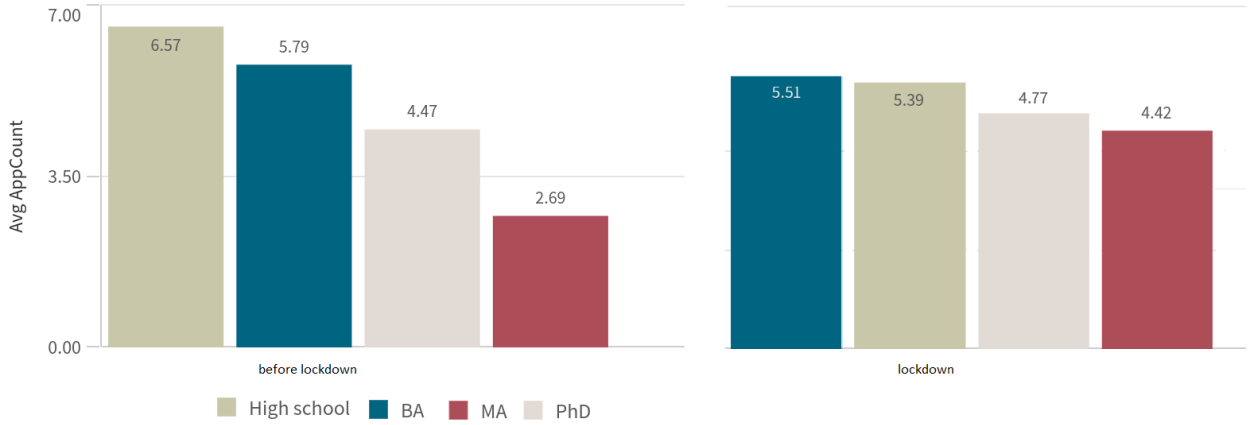


Education

Figure 20 compares the average application usage count based on educational level. The pre-lockdown usage pattern shows that high school certificate holders used the highest number of apps, followed by Bachelor's and Ph.D. degree holders. But during lockdown, Bachelor's degree holders used, on average, the highest number of

apps, followed by high school certificate holders and Ph.D. degree holders. A comparison of average app counts before and during lockdown shows a significant decrease in the number of apps used by high school certificate holders. Another significant difference is a drastic increase in the number of apps used by Master's degree holders, from 2.69 before lockdown to 4.42 during lockdown.

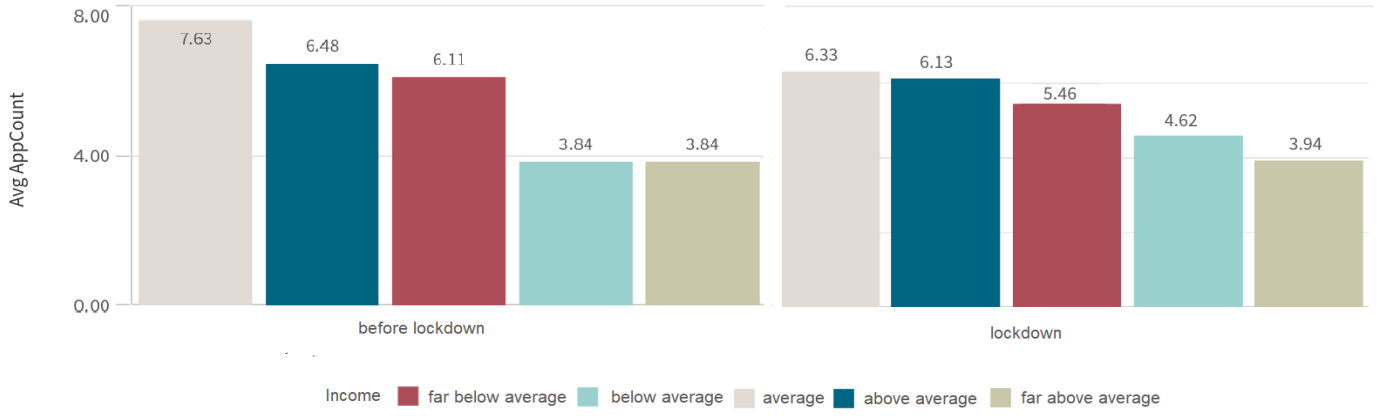
Figure 20. Comparison of the Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval in Pre-Lockdown and Lockdown, by Education Level



Income

The average app counts showed several remarkable changes from pre-lockdown to lockdown in terms of users' income levels. Based on Figure 21, it is apparent that the average income group used the highest number of smartphone applications on average, both in the pre-lockdown and lockdown periods. They were followed by the above-average and far below-average income level groups, respectively, both in the pre-lockdown period and lockdown period. Overall, we observed a decrease in the average number of apps used by individuals who reported their income levels as above-average, average, and far below-average. However the average number of apps increased for people who reported their income level as below-average.

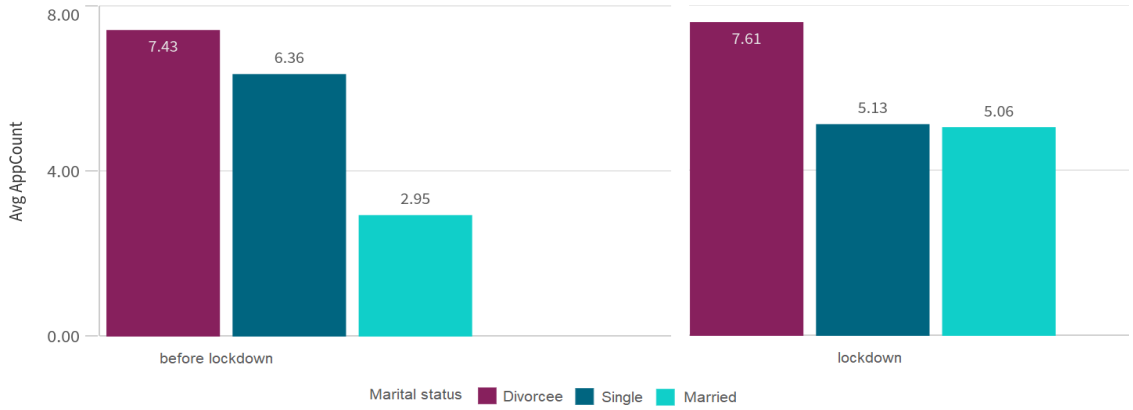
Figure 21. Comparison of the Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval in Pre-Lockdown and Lockdown, by Income Level



Marital status

Figure 22 compares the average number of applications used before lockdown and during lockdown for people with different marital statuses. One of the main differences between the pre-lockdown and lockdown periods is the drastic increase in the number of average apps used by married people, from 2.95 to 5.06. Single people's usage declined from the pre-lockdown period to lockdown period, from 6.36 to 5.13.

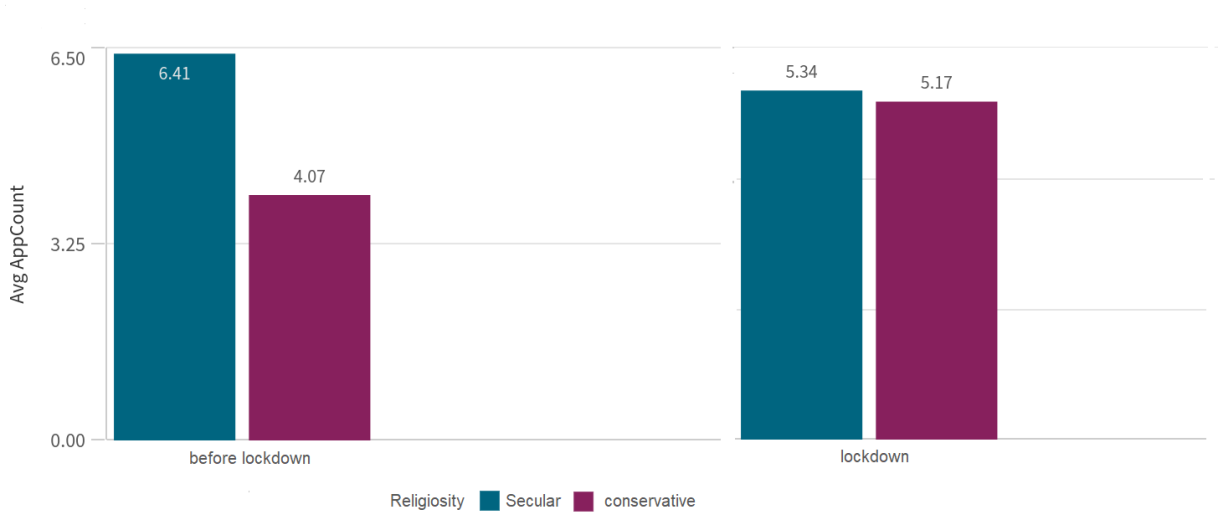
Figure 22. Comparison of the Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval in Pre-Lockdown and Lockdown, by Marital Status



Religiosity

Figure 23 compares the average number of applications used before lockdown and during lockdown for secular and conservative people. One of the most significant pre-lockdown vs. lockdown differences is the decrease in the number of apps used by secular people. Before lockdown, secular people used on average 6.41 apps. This number fell to 5.34 during lockdown. Conversely, conservatives' average number of apps increased from the pre-lockdown period to lockdown period.

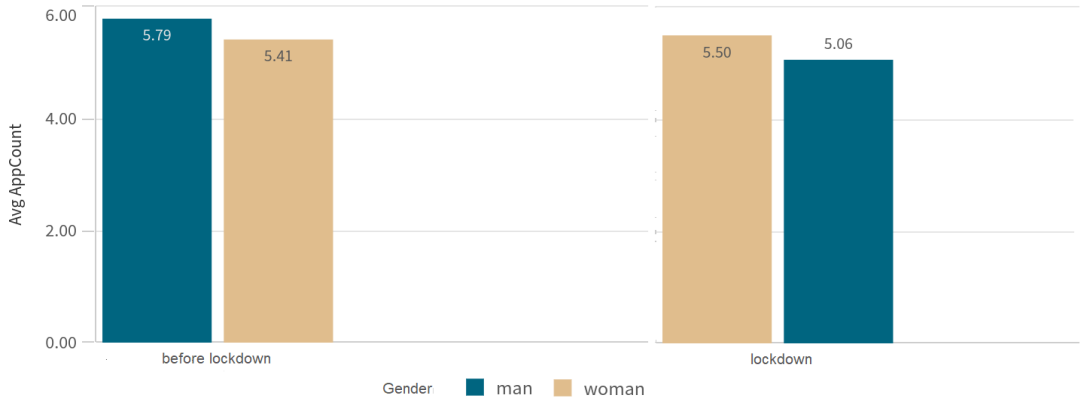
Figure 23. Comparison of the Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval in Pre-Lockdown and Lockdown, by Religiosity



Gender

Overall, men's application use decreased during lockdown from pre-lockdown to lockdown (see Figure 23). Before lockdown, men were using slightly more apps (5.79) than women (5.41). We observe that women (5.50) used slightly more apps during lockdown than men (5.06).

Figure 24. Comparison of the Average Open (Foreground and Background) Smartphone Applications per Ten-Minute Interval in Pre-Lockdown and Lockdown, by Gender



DISCUSSION

Smartphones offer efficient and convenient methods for users to perform many personalized services, such as banking, email, navigation, shopping, and social networking. Similarly, smartphones allow users to access cloud-stored information and to control other appliances and gadgets that are paired with their smartphones. The extensive private data amassed by smartphone creates a situation where any security breach could result in unfavorable outcome for users. Therefore, it is important to identify the potential vector of attacks which could be employed by online offenders who seek to target smartphone users. Since humans' usage and operation of IT systems play a significant role in information security (Lacey, 2011), it is crucial to understand their interaction and the modes by which users exchange information with the IT system (Li et al., 2018). This study aims to do just that.

Preliminary findings suggest that among Israeli Android users, the highest average number of open applications occurred between noon and 8pm. Moreover, WhatsApp was the most used application among these users, followed by Gmail and social media applications. These patterns disclose both the times and mediums by which online offenders could potentially target Israeli victims. Moreover, we observed that during the COVID-19 pandemic there was a substantial increase in cyberattacks and cybercrimes (Buil-Gil et al., 2021; Yacobi-Handelsman, 2020), some of which can be explained by the smartphone usage patterns observed in our primary findings. The COVID-19 pandemic has resulted in a significant increase in cybercrimes and cyberattacks, with phishing and hacking often focusing on instant messaging and social media platforms (Chigada & Madzinga, 2021; Nagar, 2019; Buil-Gil et al., 2021).

The increased usage of apps like WhatsApp, Facebook, Instagram, and Twitter—both during COVID-19 in general and during the lockdowns specifically—may explain the substantial number of recorded cybercrime incidents on those platforms. Likewise, the common use of Gmail and smartphone devices in general may explain the substantial increase in phishing and smishing attacks. Since the beginning of the pandemic, there have been substantial increases in COVID-19-themed and finance-themed phishing attacks (Cook, 2020; Chigada & Madzinga, 2021; Buil-Gil et al., 2021).

At this point, we are not sure whether there are relationships between this observed application usage and cyber-victimization or whether other behavioural patterns influence cybersecurity vulnerability. We intend to investigate those issues in a future report.

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