

Electronic Media Abstinence in Sabbath Observant Jews: A Comparison Between the Weekday and Sabbath

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ABSTRACT **Background:** Dependence on technology and electronic media devices (EMDs) is a significant phenomenon of modern life with many people experiencing adverse symptoms during abstinence. Orthodox Jews abstain from using all forms of EMDs for 25 consecutive hours every week on the Sabbath but do not appear to experience significant adverse reactions during this abstinence.

Objectives: To better examine whether Sabbath observant Jews experience fewer and less severe adverse symptoms while abstaining from EMDs on the Sabbath compared to weekdays.

Methods: Ten Sabbath observant Jews abstained from using all forms of EMDs for 25 hours on a Sabbath and again on a weekday. At the end of each 25-hour period participants completed a 12-item Likert-type scale self-assessment of 1–5, once as a report of their condition at 10:00 and again after 25 hours of abstaining. The authors compared the mean results of Sabbath and weekday using Wilcoxon signed ranks test. $P \leq 0.05$ was considered significant.

Results: Overall, discomfort on Sabbath was less than on weekdays. A statistically significant decrease on the Sabbath was found at both the 10:00 reporting time and after 25 hours in anxiety, restlessness, thoughts and plans of using devices, and overall difficulty to abstain. Significance was found for feelings of not knowing what to do with time (10:00) and moodiness and irritability, being drawn to devices, and cravings achieved significance (after 25 hours).

Conclusions: Sabbath observant Jews reported statistically significant less adverse reactions while abstaining from EMDs on the Sabbath compared to on a weekday.

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The widespread adoption of electronic media devices (EMDs) has become a defining feature of life in the 21st century. As we become more reliant on these devices, our relationship with them becomes increasingly complex. On one hand, they enhance quality of life by increasing convenience, enabling communication, providing access to information, and entertaining users. On the other hand, their inappropriate use and overuse can decrease quality of life, and increase dependency and addiction [1].

Technology addiction is described by Griffiths as, “non-chemical (behavioral) addiction that involves human-machine interaction” [2]. The very nature of our handheld technology involves interactions with both hardware (the devices themselves) and software (the contents and programs accessible on these devices). As such, the problematic behavior can be as variegated as any possible combination of hardware and software stimulus.

Cell phone addiction has been described as possibly the most common non-drug addiction of the 21st century [1]. In the United States its prevalence has been reported as 25% [3]. The age groups that are most vulnerable are teenagers and college students [1]. According to a 2019 Pew Research Center report 99% of 18 to 29 year olds own a cell phone, of which 96% are smartphones [4]. According to an industry study the average person has been reported to touch their cellphone over 2600 times a day [5]. In 2011 and 2013 U.S. college students reported spending nearly 9 hours daily on their cellphones and 60% acknowledged they may be addicted to their smartphone [1]. A PEW report found that 86% of Americans access the internet using their mobile devices. Of these people, 92% go online daily and 32% are online almost constantly [6].

Studies describe users reporting negative reactions when separated from their cellphones. These feelings include anticipation and cravings for their devices, dysphoria, distress, depressed mood, restlessness, irritability, anxiety, impatience, agitation, loneliness, boredom, and a sense of being lost [1,7,8]. Some people went so far as to describe feeling that they are unable to live without these devices [1]. These symptoms are essentially the same as those seen with drug addiction withdrawal [7,9].

*The first and second authors contributed equally to this study

The 24 Hours: Unplugged study [10], conducted by the International Center for Media & the Public Agenda (ICMPA) at University of Maryland, USA, examined the reliance of college students on all forms of technology and media. The World Unplugged Project was a follow-up multinational, multicenter, qualitative study of nearly 1000 participants. In both studies, participants were required to abstain for 24 hours from all electronic media (including computers, cell phones, internet, social media, television, radio, and other media devices) as well as print media.

Many of the participants reported feeling negative mood states and adverse psychological reactions, which suggested a degree of psychological dependence or addiction. Discomfort was significant enough that a clear majority of participants could not complete the 24-hour period of abstinence [10]. The researchers at ICMPA reported that students used the same terms as people with drug and alcohol addictions to describe how they felt. Students described withdrawal symptoms, including cravings, anxiety, restlessness as well as feeling miserable, jittery, and crazy. The researchers concluded that most students were functionally unable to be without their media links [9,10]. Use of electronic media has increased dramatically since these studies were conducted in 2010–2012, which would suggest that in 2020 negative effects would be increased.

Sabbath observant Jews abstain from using all forms of technology and electronic media devices for 25 consecutive hours every week on the Sabbath, which starts Friday at sunset and ends at nightfall on Saturday [11]. On a number of religious holidays, this abstention may extend to 2 to 3 consecutive days (approximately 49–73 hours). The authors noticed that Sabbath observant Jews do not seem to experience the same negative symptoms during these religious holy days. Interestingly, some of these symptoms do indeed seem to appear in the same individuals during extended non-religious periods of abstinence. We hypothesized that Sabbath observant Jews experience less adverse reactions to EMD abstention on the Sabbath compared to non-Sabbath days.

A similar phenomenon has been studied regarding cigarette and nicotine use in Sabbath observant Jews who are also religiously forbidden to smoke during this aforementioned 25-hour period of the Sabbath. Studies have shown that these individuals experience lower levels of craving and fewer symptoms of withdrawal while abstaining from smoking on the Sabbath compared to abstaining during a non-Sabbath day [12–15].

The aim of our study was to better examine whether Sabbath observant Jews react differently to abstention from EMDs on the Sabbath compared to non-Sabbath days.

PATIENTS AND METHODS

A protocol was developed in which participants were requested to abstain from the use of EMDs for two 25-hour time periods, one on a Sabbath and the other on a regular weekday. Following

each period participants were instructed to complete a 12-item questionnaire examining their status at two points in time. Results were compared. The study protocol was approved by the ethics committee of Rambam Health Care Campus.

Participants were recruited from Technion American Medical School (TeAMS) using social media outlets (e.g., Facebook and WhatsApp). Recruitment criteria included: enrollment in the TeAMS program (or a spouse of a student), fluency in English, and Sabbath observance including strict adherence to the prohibition of using electronic media devices on the Sabbath and Jewish holidays. Participants were offered compensation of NIS 200 (~US\$50). Respondents were informed of the process of the experiment but not its purpose. Although many respondents met the recruitment criteria, only 10 agreed to participate in the experiment. All participants gave written informed consent.

A 12-item questionnaire was formulated and validated (Cronbach α 0.934) to assess the presence and intensity of reactions experienced by participants. Each self-reported item consisted of a Likert-type scale of 1 to 5 (1 = not at all, 5 = very much). The items were: satisfaction, moodiness, intrusive thoughts, trouble sleeping, anxiety, thoughts of planning or using devices, restlessness, general depressed mood, not knowing what to do with free time, repeatedly reaching for devices, craving of electronic devices, and overall difficulty to abstain.

Our study population consisted of 10 participants: 6 men and 4 women. Nine were medical students, one man was the spouse of a student. The women ranged in age from 25–27 years (mean age 26 years). Men ranged in age from 23–28 years (mean age 25 years).

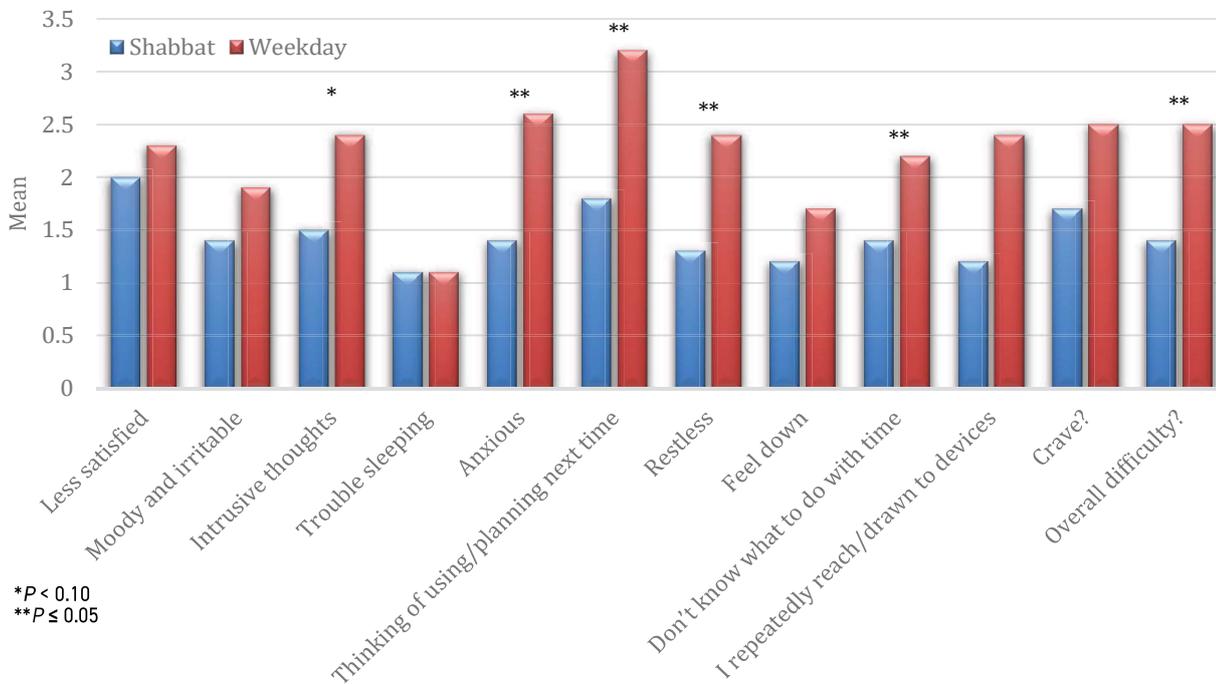
Participants were informed of the 12 items before the abstention period. At the end of each abstention period they were instructed to complete the questionnaire as a retrospective report of their condition for two different points in time: the first as a report of their condition at 10:00 and the second as a report of their condition after 25 hours of abstaining. Retrospection was needed because writing is prohibited on Sabbath [16]. We considered all non-Sabbath days to be equal for the purposes of our study. This method was validated in the World Unplugged study in which no difference was reported on different non-Sabbath days [10]. We also assumed that there would be no difference if the first day of abstention was a Sabbath or a weekday. Dar et al. [12] found this to be true for smoking.

Four data sets were obtained: Set A was Sabbath at 10:00, Set B was Sabbath after 25 hours of abstaining, Set C was weekday at 10:00, and Set D was weekday after 25 hours of abstaining. A mean was calculated for each item in these sets.

Four analyses were performed to compare the means:

- Mean of each item for sets A and set B
- Mean of each item for sets C and set D
- Mean of each item for sets A and set C
- Mean of each item for sets B and set D

Figure 1. Adverse reactions on the Sabbath vs. a weekday at 10:00



The data was analyzed by a statistician from the Department of Epidemiology at Rambam Health Care Campus. Statistical analyses were performed using IBM Statistical Package for the Social Sciences statistics software, version 25 (SPSS, IBM Corp, Armonk, NY, USA). Differences within groups were tested using Wilcoxon signed ranks test. Results were considered significant if they achieved a *P* value ≤ 0.05.

RESULTS

The means of the 12 items of sets A and B (the two time points on the Sabbath) showed no statistically significant differences [Table 1]. Comparing the mean of the 12 items of set C and D (the two time points on a weekday), one item—cravings—achieved statistical significance (10:00 mean 2.500 ± 1.08012, 25 hour mean 3.300 ± 1.25167, *P* = 0.038). Two items—moodiness/irritability and restlessness—approached statistical significance (*P* < 0.10). For moodiness/irritability, the 10:00 mean was 1.900 ± 1.10050, 25 hour mean 2.500 ± 1.35401, *P* = 0.059. For restlessness, the 10:00 mean was 2.400 ± 0.96609, and 25 hour mean was 3.00 ± 1.05409, *P* = 0.098 [Table 1].

Comparing the means of 12 items of sets A and C (Sabbath vs. weekday at 10:00), 11 parameters for the Sabbath were lower than the weekday and one (trouble sleeping) showed no difference. Of the 11, five achieved statistical significance (*P* ≤ 0.05). These were feelings of anxiety (Sabbath mean 1.400 ±

0.69921, weekday mean 2.600 ± 1.17379, *P* = 0.016), thoughts and plans of using devices (Sabbath mean 1.800 ± 1.03280, weekday mean 3.200 ± 1.22927, *P* = 0.017), restlessness (Sabbath mean 1.300 ± 0.67495, weekday mean 2.400 ± 0.96609, *P* = 0.005), not knowing what to do with my time (Sabbath mean 1.400 ± 0.96609, weekday mean 2.200 ± 1.13529, *P* = 0.05), and overall difficulty to abstain (Sabbath 1.400 ± 0.96609, weekday 2.500 ± 1.43372, *P* = 0.05). One parameter, intrusive thoughts, approached significance (Sabbath 1.500 ± 1.26930, weekday 2.400 ± 1.26491, *P* = 0.08) [Table 2, Figure 1].

Comparing the means for the 12 items of sets B and D (Sabbath vs. weekday at 25 hours of abstinence), all for Sabbath were lower than the weekday. Of the 12, seven achieved statistical significance (*P* ≤ 0.05). These were: moodiness and irritability (Sabbath mean 1.200 ± 0.63246, weekday mean 2.500 ± 1.35401, *P* = 0.001), feelings of anxiety (Sabbath mean 1.400 ± 0.69921, weekday 2.800 ± 1.22927, *P* = 0.05), thoughts and plans of using devices (Sabbath 1.900 ± 1.28668, weekday 4.000 ± 0.66667, *P* = 0.001), restlessness (Sabbath 1.300 ± 0.94868, weekday 3.000 ± 1.05409, *P* = 0.014), being drawn to and reaching for devices (Sabbath 1.100 ± 0.31623, weekday 3.100 ± 1.59513, *P* = 0.001), cravings (Sabbath 1.600 ± 0.84327, weekday 3.300 ± 1.25167, *P* = 0.014), and overall difficulty to abstain (Sabbath 1.400 ± 0.96609, weekday 3.000 ± 1.33333, *P* = 0.001). Three parameters approached significance, intrusive thoughts (Sabbath 1.300 ± 0.67495, weekday 2.500

Figure 2. Adverse reactions on the Sabbath vs. a weekday at 25-hours

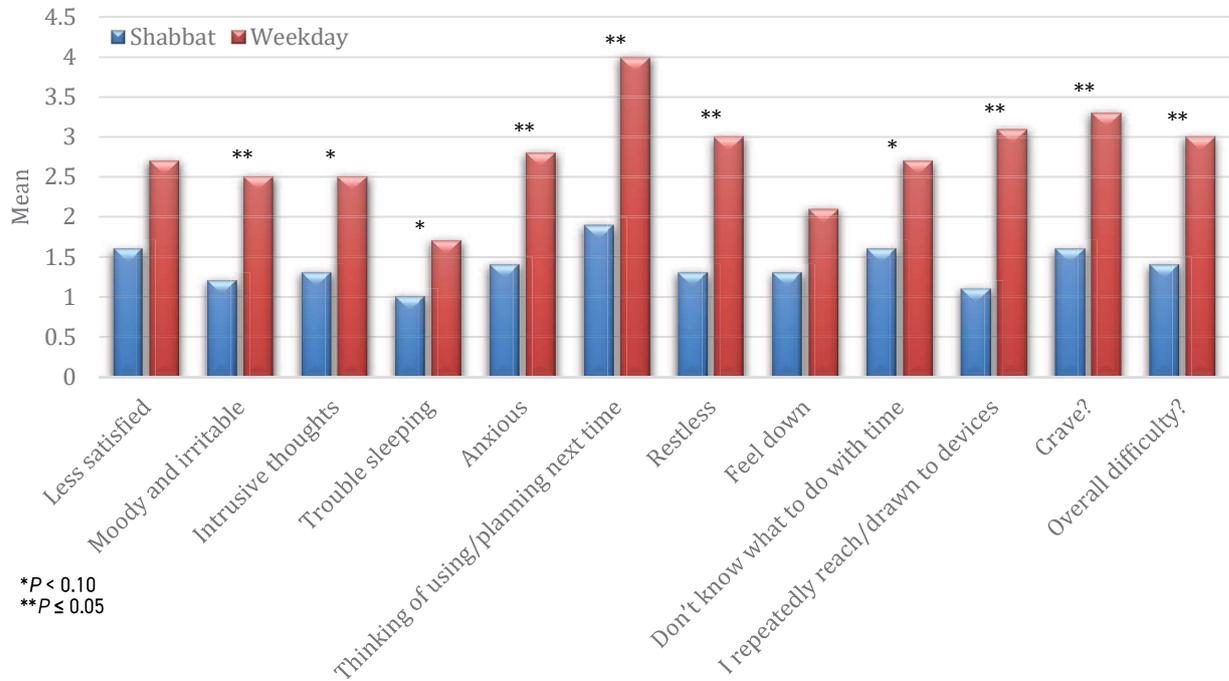


Table 1. Adverse reactions to abstention from electronic media devices, comparing 10:00 to 25-hour time points on a Sabbath as well as at 10:00 and after 25 hours on a weekday

When I am abstaining from using electronic media devices...	Sabbath		P value	Weekday		P value
	10:00 ± SD	25-hour ± SD		10:00 ± SD	25-hour ± SD	
I feel less satisfied	2.0 ± 1.70	1.6 ± 1.07	0.460	2.3 ± 1.16	2.7 ± 1.25	0.180
I get moody and irritable	1.4 ± 1.26	1.2 ± 0.63	0.320	1.9 ± 1.10	2.5 ± 1.35	0.059
I have intrusive thoughts	1.5 ± 1.27	1.3 ± 0.67	0.410	2.4 ± 1.26	2.5 ± 1.18	0.780
I have trouble sleeping	1.1 ± 0.32	1.0 ± 0.00	0.320	1.1 ± 0.32	1.7 ± 1.06	0.110
I feel anxious	1.4 ± 0.70	1.4 ± 0.70	1.000	2.6 ± 1.17	2.8 ± 1.23	0.320
I am thinking about using them or planning the next time I can use them	1.8 ± 1.03	1.9 ± 1.29	0.560	3.2 ± 1.23	4.0 ± 0.67	0.120
I feel restless	1.3 ± 0.67	1.3 ± 0.95	1.000	2.4 ± 0.97	3.0 ± 1.05	0.098
I feel generally down	1.2 ± 0.63	1.3 ± 0.95	0.320	1.7 ± 0.95	2.1 ± 1.10	0.320
I feel that I don't know what to do with my time	1.4 ± 0.97	1.6 ± 0.97	0.160	2.2 ± 1.14	2.7 ± 0.94	0.210
I repeatedly reach for my phone or I am drawn to my electronic devices	1.2 ± 0.42	1.1 ± 0.32	0.320	2.4 ± 1.58	3.1 ± 1.60	0.140
How much did you crave electronic devices?	1.7 ± 1.06	1.6 ± 0.84	0.560	2.5 ± 1.08	3.3 ± 1.25	0.038
Overall, how difficult was it to abstain?	1.4 ± 0.97	1.4 ± 0.97	1.000	2.5 ± 1.43	3.0 ± 1.33	0.300

SD = standard deviation
Bold indicates significance

Table 2. Adverse reactions to abstention from electronic media devices on the Sabbath as well as at 10:00 and after 25 hours on a weekday

When I am abstaining from using electronic media devices...	Sabbath	Weekday	P value	Sabbath	Weekday	P value
	10:00 ± SD			25-hour ± SD		
I feel less satisfied	2.0 ± 1.70	2.3 ± 1.16	0.350	1.6 ± 1.07	2.7 ± 1.25	0.130
I get moody and irritable	1.4 ± 1.26	1.9 ± 1.10	0.190	1.2 ± 0.63	2.5 ± 1.35	0.001
I have intrusive thoughts	1.5 ± 1.27	2.4 ± 1.26	0.080	1.3 ± 0.67	2.5 ± 1.18	0.063
I have trouble sleeping	1.1 ± 0.32	1.1 ± 0.32	1.000	1.0 ± 0.00	1.7 ± 1.06	0.051
I feel anxious	1.4 ± 0.70	2.6 ± 1.17	0.016	1.4 ± 0.70	2.8 ± 1.23	0.050
I am thinking about using them or planning the next time I can use them	1.8 ± 1.03	3.2 ± 1.23	0.017	1.9 ± 1.29	4.0 ± 0.67	0.001
I feel restless	1.3 ± 0.67	2.4 ± 0.97	0.005	1.3 ± 0.95	3.0 ± 1.05	0.014
I feel generally down	1.2 ± 0.63	1.7 ± 0.95	0.160	1.3 ± 0.95	2.1 ± 1.10	0.100
I feel that I don't know what to do with my time	1.4 ± 0.97	2.2 ± 1.14	0.050	1.6 ± 0.97	2.7 ± 0.95	0.080
I repeatedly reach for my phone or I am drawn to my electronic devices	1.2 ± 0.42	2.4 ± 1.58	0.140	1.1 ± 0.32	3.1 ± 1.60	0.001
How much did you crave electronic devices?	1.7 ± 1.06	2.5 ± 1.08	0.100	1.6 ± 0.84	3.3 ± 1.25	0.014
Overall, how difficult was it to abstain?	1.4 ± 0.97	2.5 ± 1.43	0.050	1.4 ± 0.97	3.0 ± 1.33	0.001

SD = standard deviation
 Bold indicates significance

± 1.17851, *P* = 0.063), trouble sleeping (Sabbath mean 1.000 ± 0.000, weekday 1.700 ± 1.05935, *P* = 0.051), and not knowing what to do with my time (Sabbath 1.600 ± 0.96609, weekday 2.700 ± 0.94868, *P* = 0.08) [Table 2, Figure 2].

DISCUSSION

We conducted a pilot study to examine whether Sabbath observant Jews experience less adverse reactions while abstaining from EMDs on a Sabbath compared to a weekday. The results suggest that there is an overall decrease in adverse reactions.

The Jewish Sabbath is observed as a day of rest by traditional Jews. The Sabbath spans approximately 25 consecutive hours, beginning Friday night at sundown and ending Saturday night. On the Sabbath, observant Jews do not use EMDs [11,16]. Of note, writing is also forbidden, which is why participants were unable to complete the questionnaires on the Sabbath [16].

Addiction can be characterized by three essential elements: craving or compulsion, loss of control, and persistence in the behavior despite accruing adverse consequences [17,18]. The term addiction has been used by DSM5 primarily to refer to substance use disorder (substance addiction) [19]. The concept of behavioral addictions (non-substance addictions) is still controversial. The only behavioral addiction recognized by DSM5

is gambling addiction. Other behaviors such as internet gaming, sex, excessive exercise, and shopping have been listed as topics that require more research [19,20].

Technology addictions are a broad category of behavioral addictions characterized by human-machine interactions [2]. Each form of technology addiction can be viewed in a global sense or it can be broken down into specific interactions with addictive contents and activities [7].

Most studies that explore negative effects of technology focus on only one aspect, either a medium or device. In contrast, our study is agnostic to the EMD used, rather it focuses on the effect of abstaining from all such devices. We focused on whether abstaining from all EMDs would result in more numerous and pronounced adverse negative effects. The only analogous study we could find was one published by Moeller et al. [9] in which participants unplugged from all EMDs for 24 hours. The vast majority of those participants experienced adverse reactions and were unable to abstain for the full period. It is conceivable that, given the significant increase in use of EMDs, findings in 2020 would be more pronounced.

There are some notable differences between our study and the one by Moeller et al. [9]. Moeller's group included all forms of media, while our study involved only EMDs. Their population consisted primarily of undergraduate students, our population consists of medical students and their spouses.

Many of the concepts and methodology of our study were based on the literature that explored Sabbath observance and smoking. Shiffman [14] and Schachter et al. [15] reported that even heavily addicted smokers who experience difficulty abstaining during weekdays experience little to no discomfort while abstaining on the Sabbath. Dar and co-authors [12] and Munter et al. [13] conducted prospective studies to better explore this phenomenon.

Dar et al. [12] conducted a crossover study of 20 Sabbath observant smokers. That study compared symptoms and cravings during their Sabbath abstention to both a 25-hour weekday abstention and to a non-abstention weekday. They concluded that cravings, irritability, and difficulty in abstaining were significantly lower during Sabbath than during the weekday [12].

Munter and colleagues [13] examined symptoms of nicotine withdrawal for 49 Sabbath observant smokers on the morning following an overnight abstention on a Sabbath compared to the morning following an overnight abstention on a weekday. They also compared them to a control group of 39 non-Sabbath observant smokers on the morning following an overnight abstention. The researchers measured depression, difficulty sleeping, anger, difficulty concentrating, restlessness, increased appetite, and cravings. Following the weekday overnight abstention, the Sabbath observant group reported experiencing overall increased symptoms and a statistically significant increase in cravings compared to the secular control group. However, on the Sabbath itself the Sabbath observant group experienced decreased symptoms compared to the weekday, which were significant for most parameters [13].

We conducted a small exploratory study to investigate whether Sabbath observant Jews have fewer and less intense adverse reactions while abstaining from EMDs on the Sabbath compared to weekdays.

We were unable to find a validated questionnaire to assess symptoms of withdrawal from EMDs. Thus, we developed our own and chose the 12 parameters based on symptoms that were discussed in the literature and anecdotal reports. The questionnaire was validated in a separate study with 39 participants. A high internal validity was demonstrated with a Cronbach α of 0.934. In Dar et al. [12] and Munter et al. [13] as well as in our study, participants completed part of the questionnaire retrospectively.

The data suggest that, overall, discomfort on Sabbath was less than on weekdays. A statistically significant decrease was found for both points in time in anxiety, thoughts and plans of using devices, restlessness, and overall difficulty to abstain. At 10:00 feelings of not knowing what to do with time achieved significance and intrusive thoughts approached significance. At 25 hours experiencing moodiness and irritability, being drawn to and reaching for devices, and craving achieved significance, having intrusive thoughts, experiencing trouble sleeping, and not knowing what to do with time approached significance.

There are several possible explanations for our findings. Regarding the decrease of nicotine cravings on Sabbath, Dar et al. [12] suggest that urges are "significantly determined by habits, cues, and expectations." On the Sabbath, observant Jews have the expectation that they will not smoke. They are in a different environment and less likely to encounter smokers. Munter et al. [13] speculate that, "fulfilling a divine command in itself compensates for the craving and withdrawal." These findings may very well apply to our study.

LIMITATIONS

A significant limitation of our study is the small sample size. Our study population was homogeneous, limited to Sabbath observant TeAMS students and their spouses. Most of this population was unwilling to join this study with a weekday abstention component even when financial compensation was offered. Perhaps this selection bias was evident in this group: the willingness of participants to participate in weekday abstention may have been a reflection of their greater confidence in their ability to abstain on weekdays. This confidence may have skewed results toward fewer symptoms on the weekday. This bias actually enhances the significance of our positive findings. An additional limitation is that participants completed the forms retrospectively after the Sabbath.

A potential criticism of this study is that observant Jews typically find themselves in a Sabbath environment that has much less exposure to EMDs. In addition, Israeli society at large does not expect religious Jews to be easily reachable by electronic means on the Sabbath, lessening the psychological pressure to use EMDs. These factors may make it easier to abstain. These criticisms do not apply to our study group because for our participants EMDs were omnipresent even on the Sabbath. In addition, fear of missing out may still be felt on the Sabbath because electronic messages are still being sent, social media groups are still active, and new content is still released. Furthermore, most participants were originally from North America. Given that they typically have family in time zones 7–10 hours behind their own, communications would be expected to continue well after the Sabbath begins in Israel.

Future studies are needed to explore the effects of an increased sample size, more varied population as well as 2- and 3-day holidays. Perhaps these effects are present among members of other faith groups such as the prohibition against smoking during Ramadan [21]. It may be worthwhile to explore harnessing religious abstinence for therapeutic purposes.

CONCLUSIONS

Negative effects from abstention from EMDs on the Sabbath are less apparent among Sabbath observant Jews.

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Capsule

Clinical course and molecular viral shedding among asymptomatic and symptomatic patients with SARS-CoV-2 infection in a community treatment center in the Republic of Korea

Lee et al. conducted a retrospective evaluation on a cohort of 303 symptomatic and asymptomatic patients with SARS-CoV-2 infection between 6 March and 26 March 2020. Participants were isolated in a community treatment center in Cheonan, Republic of Korea. Of the 303 patients with SARS-CoV-2 infection, the median (interquartile range) age was 25 (22–36) years, and 201 (66.3%) were women. Only 12 (3.9%) patients had co-morbidities (10 had hypertension, 1 had cancer, and 1 had asthma). Among the 303 patients with SARS-CoV-2 infection, 193 (63.7%) were symptomatic at the time of isolation. Of the 110 (36.3%) asymptomatic patients, 21 (19.1%) developed symptoms during isolation. The median (interquartile range) interval of time from detection of SARS-CoV-2 to symptom onset in pre-symptomatic patients was 15 (13–20) days. The

proportions of participants with a negative conversion at day 14 and day 21 from diagnosis were 33.7% and 75.2%, respectively, in asymptomatic patients and 29.6% and 69.9%, respectively, in symptomatic patients (including pre-symptomatic patients). The median (SE) time from diagnosis to the first negative conversion was 17 (1.07) days for asymptomatic patients and 19.5 (0.63) days for symptomatic (including pre-symptomatic) patients ($P = .07$). The Ct values for the envelope (*env*) gene from lower respiratory tract specimens showed that viral loads in asymptomatic patients from diagnosis to discharge tended to decrease more slowly in the time interaction trend than those in symptomatic (including pre-symptomatic) patients ($\beta = -0.065$ [SE, 0.023]; $P = .005$).

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Capsule

Immune profiling of COVID-19 patients

Coronavirus disease-2019 (COVID-19) has affected millions of people globally, yet how the human immune system responds to and influences COVID-19 severity remains unclear. **Mathew** et al. presented a comprehensive atlas of immune modulation associated with COVID-19. They performed high-dimensional flow cytometry of hospitalized COVID-19 patients and found three prominent and distinct immunotypes that are related

to disease severity and clinical parameters. **Arunachalam** et al. reported a systems biology approach to assess the immune system of COVID-19 patients with mild-to-severe disease. These studies provide a compendium of immune cell information and roadmaps for potential therapeutic interventions.

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Capsule

Estimating the effects of non-pharmaceutical interventions on COVID-19 in Europe

Flaxman and colleagues studied the effect of major interventions across 11 European countries for the period from the start of the COVID-19 epidemics from February 2020 until 4 May 2020, when lockdowns started to be lifted. The model calculates backward from observed deaths to estimate transmission that occurred several weeks previously, allowing for the time lag between infection and death. The authors use partial pooling of information between countries, with both individual and shared effects on the time-varying reproduction number (R_t). Pooling allows for more information to be used, helps to overcome idiosyncrasies in the data and enables more timely estimates. The model relies on fixed estimates of some epidemiological parameters (such as the infection fatality rate), does not include importation or sub-national variation and assumes that changes in R_t are an immediate response to interventions rather than gradual

changes in behavior. Amidst the ongoing pandemic, the authors relied on death data that are incomplete, show systematic biases in reporting, and are subject to future consolidation. They estimate that for all of the countries that were considered, current interventions have been sufficient to drive R_t below 1 (probability $R_t < 1.0$ is greater than 99%) and achieve control of the epidemic. They estimate that across all 11 countries combined, between 12 and 15 million individuals were infected with SARS-CoV-2 until 4 May 2020, representing between 3.2% and 4.0% of the population. The results showed that major non-pharmaceutical interventions, and lockdowns in particular, had a large effect on reducing transmission. Continued intervention should be considered to keep transmission of SARS-CoV-2 under control.

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Capsule

The effect of large-scale anti-contagion policies on the COVID-19 pandemic

Hsiang et al. compiled data on 1700 local, regional, and national non-pharmaceutical interventions that were deployed in the ongoing pandemic across localities in China, South Korea, Italy, Iran, France, and the United States. They then apply reduced-form econometric methods, commonly used to measure the effect of policies on economic growth, to empirically evaluate the effect that these anti-contagion policies have had on the growth rate of infections. In the absence of policy actions, we estimate that early infections of COVID-19 exhibit exponential growth rates of approximately 38% per day. The authors found that anti-contagion policies have significantly and substantially slowed this growth. Some policies have different effects on

different populations, but they obtain consistent evidence that the policy packages that were deployed to reduce the rate of transmission achieved large, beneficial and measurable health outcomes. They estimate that across these 6 countries, interventions prevented or delayed on the order of 61 million confirmed cases, corresponding to averting approximately 495 million total infections. These findings may help to inform decisions regarding whether or when these policies should be deployed, intensified or lifted, and they can support policy-making in the more than 180 other countries in which COVID-19 has been reported.

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