Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Journal of Psychosomatic Research 139 (2020) 110282

Contents lists available at ScienceDirect

Journal of Psychosomatic Research

journal homepage: www.elsevier.com/locate/jpsychores

Stay-at-home circumstances do not produce sleep disorders: An international survey during the COVID-19 pandemic

AMHSI Research Team[a,1], Milken Research Team[b,2], Yulia Roitblat[c], Jacob Burger[d], Aidan Leit[e], Liliia Nehuliaieva[f], Gulrukh Sh. Umarova[g], Vitalii Kaliberdenko[h], Shanmugaraj Kulanthaivel[i], Noa Buchris[j], Michael Shterenshis[a,*]

[a] Science Research Department, Alexander Muss High School in Israel (AMHSI) affiliated with Alexander Muss Institute for Israel Education (AMIIE), Hod HaSharon, Israel
[b] Science Research Department, Milken Community High School, Los Angeles, CA, USA
[c] Matan Chen Manpower for Nursing Ltd., Rishon-LeZion, Israel
[d] Dept. of Sciences, Sharon High School, Sharon, MA, USA
[e] Dept. of Sciences, The Harley School, Rochester, NY, USA
[f] Andrei Krupynskyi Lviv Medical Academy, Lviv, Ukraine
[g] Tashkent Medical Academy, Uzbekistan
[h] Department of Internal Medicine, No. 2, V.I. Vernadsky Crimean Federal University, Russian Federation
[i] Naarayani Multispeciality Hospital, Kavindapadi, Erode, India
[j] Child and Adolescent Development, California State University, Northridge, CA, USA

ARTICLE INFO

Keywords:
Coronavirus
COVID-19
Sleep habits
Stay-at-home
International survey

ABSTRACT

Objective: The anxiety-related insomnia and other sleep disorders were mentioned as possible side effects of quarantine and stay-at-home conditions. The questions to be explored were: Are there discernable differences in hours of sleep and sleep habits between the normal operational environment and the stay-at-home condition? and How seriously *anxiety-induced insomnia* or other sleep disorders may affect individuals during the stay-at-home?

Methods: This international prospective study analyzed results from the sleep-wake patterns questionnaire, daily logs, and interviews. During COVID-19 pandemic, surveys were administered to the healthy volunteers with stay-at-home for 14 days or more, without previous sleep disorders; volunteers were not involved in online education/work daily timetable-related activities.

Results: We analyzed 14,000 subjects from 11 countries with average stay-at-home of 62 days. The most significant changes in sleep occurred during the first 14 days of stay-at-home. The difference in the sleep duration between weekdays and weekends disappeared. Most of the participants discontinued using alarm clocks. The total sleep time increased in duration up to 9:10 ± 1:16 to the end of the quarantine/stay-at-home (+1:34, $p = 0.02$). The age-dependent changes in napping habits occurred. Only 1.8% of participants indicated insomnia during the first 14-day period with a decline to 0.5% after two months of stay-at-home.

Conclusion: During the stay-at-home situation, both duration and timing of sleep significantly differ from those of daily routine and most humans sleep longer than in a schedule-dependent operational environment. An appearance of anxiety-induced insomnia is extremely rare if a healthy individual is already in the stay-at-home situation.

* Corresponding author at.: Aliyat HaNoar 9, Hod HaSharon 45102, Israel.
E-mail address: mshterenshis@amhsi.org (M. Shterenshis).
[1] The full list of AMHSI Research Team members can be found at the end of this article.
[2] The full list of Milken Research Team can be found at the end of this article.

https://doi.org/10.1016/j.jpsychores.2020.110282
Received 19 June 2020; Received in revised form 2 October 2020; Accepted 23 October 2020
Available online 26 October 2020

1. Introduction

The topic of human behavior during quarantine and stay-at-home conditions is extremely understudied [1]. Sleep habits during quarantine were never studied before in detail. General articles dedicated to Ebola and SARS-related quarantines mentioned insomnia as a possible side effect without detailed analysis of the phenomenon [2–4]. The COVID-19 pandemic has put millions of humans in stay-at-home and self-quarantine situations. The COVID-19-pandemic-related WHO release and the review on the psychological impact of quarantine mentioned the possibility of "anxiety-induced insomnia" [5,6].

The topic of sleep habits, sleep disorders, and daily temporal patterns during quarantine is not just a theoretical question. The similar stay-at-home and country "lock-down" events may reappear in the future and psychologists, psychiatrists, public health professionals, and sleep disorders practitioners should be more prepared for such situations. The results might also have implications for unique variations in human chronotype as these variations apply to the optimization of daily productivity once people return to work.

The studies of sleep habits of healthy individuals concentrated on sleep duration and sleep timing. For sleep duration, the "eight hours for rest, eight hours for labour, and eight hours for amusement" was accepted as a sound possibility in the 1840s and postulated as true hygiene of sleep in the 1890s [7,8]. The eight-hours maxim was confirmed in the 20th century for "normal sleepers" [9,10] and the researchers of the 21st century established that sleep duration did not decline over the last 50 years and remains between seven and eight hours [11,12]. Sleep of healthy individuals has been studied in its relation to various stressful conditions (submarines, NASA activities, prolonged shifts, jet lag) that may lead to insufficient sleep or sleep deprivation. Self-selected sleep habits during forced leisure have not attracted the attention of researchers.

We hypothesized that the stay-at-home conditions may change the sleep habits of the involved healthy people both in sleep duration and sleep timing. The current study aimed to collect enough data to prove or disprove this hypothesis and to investigate human sleep-wake patterns in self-quarantine/stay-at-home conditions. The question to be explored was: Are there discernable differences in hours of sleep and sleep habits between the normal operational environment and the stay-at-home condition? The narrower question was: How seriously anxiety-induced insomnia or other sleep disorders may affect individuals during the stay-at-home condition?

2. Methods

2.1. Researched tools

This prospective study involved an analysis of the collected survey results. We selected four research tools: the newly designed sleep-wake patterns questionnaire (Table 1), the simplified daily log, the expanded daily log, and phone/Skype/Zoom interviews.

The existing questionnaires assessing the quality of sleep such as the Pittsburgh Sleep Quality Index (PSQI), the Athens Sleep Questionnaire (ASQ), the National Sleep Foundation (NSF, USA) screening questionnaire, and the Mini Sleep Questionnaire were examined. They could not be used in the current study in their full capacity because the inclusion criterion selected only participants without sleep disorders and sleep-related complaints. These questionnaires did not include questions about usage of morning alarms making hard to determine whether the detected sleep-wake pattern is a natural habit or a forced condition. They do not include a question about midday napping either (except NSF questionnaire) [13].

The survey contained 37 variables (Q). It avoided self-rating items and questions touching estimations and desires; only the time-related facts were to be indicated and only two questions were demographic (Q1 – age, Q2 – sex). The first part of the questionnaire (Q4 – Q9) could be filled at the initial stage of the quarantine and the subsequent part (Q10 – Q15) after 14 days of stay-at-home. If the stay-at-home was prolonged up to one month, the next part of the form should be filled (Q16 – Q20), and the last part (Q21 – Q25) should be filled after two months of the stay-at-home period (if applicable). The final question (Q26) was a free response question and was optional. Translation into local languages was done for participants from countries other than the USA, the UK, Canada, and Australia.

The purpose of the simplified daily log was to validate the questionnaire, and six variations for two main variables (V) were included: bedtime (V1) and wake-up time (V2) (specified as "with alarm clock" or "no alarm") both for night sleep and possible naps. It should be kept during the whole stay-at-home period.

The expanded daily log followed the existing Sleep Diary/Sleep Log of NSF [14], but differed from it in some points. Because of the ethics requirements, the questions about smoking, alcohol consumption, and medications were excluded. Self-rating questions such as "When I woke up for the day, I felt…" and "Throughout the day, my mood was…" were excluded and other variables were added. Our log required from a participant to document time for seven to nine variables that included food intake, mental activity (studying, calculating, teaching, work-from-home without a schedule), physical/locomotor activity (sports, cleaning, cooking, active playing with children), leisure, feeling of fatigue, bedtime and wake-up time for nocturnal sleep (the same V1 and V2), and naps/snooze/siesta (if applicable). It also should be kept during the whole stay-at-home period.

Through structured interviews, the participants should provide information on sleep timing and duration in a free conversation manner. The general approach to conducting the interview and the confidentiality of the respondents followed the NSF principles established for the 2005 "Sleep in America poll" [13]. The first 500 respondents who met the inclusion criteria were selected. The topics repeated all items of the questionnaire and touched the variables of the expanded daily log (the same V1 and V2). The main purpose of the interviews was to establish a certain temporal pattern of a participant, appearance or disappearance of sleep-related complaints, and to detect their possible evolutions during the stay-at-home period. During free-response conversations, we aimed to grasp some logic behind the possible appearance of sleep-related complaints of the participants. The participant's permission should be obtained to contact him/her at the end of each week during the stay-at-home. The survey averaged 15–20 min in length.

2.2. Participants

Surveys were administered to the volunteers who met the following inclusion criteria: stay-at-home conditions for 14 days or more, no chronic diseases, no previous sleep disorders and sleep-related or mood-related complaints, volunteers do not take sleeping pills, did not work night shifts before quarantine, and were not involved in online education/work-from-home and other daily schedule/timetable-related activities. Education/work-from-home activities without timetables and daily schedules were allowed. Volunteers who were pregnant, had any sleep disorders before the quarantine, mood disorders, take sleeping pills, or were involved in online education/work-from-home daily schedule/timetable-related activities were excluded.

The age limit was set from 15 to 60 years. The younger children were excluded because of possible parental influences. The upper limit of 60 years was set because in some surveyed countries the retirement age for women is 60 and because of age-related changes in sleep habits. The participants were divided into three age groups: adolescents (Group 1, 15–18 y), younger adults (Group 2, 19–39 y), and older adults (Group 3, 40–60 y).

The target sample size for each research tool was initially set at 500 participants to keep the margin of error below 5% (4.4% with 95% confidence interval). Due to unexpectedly active responses of volunteers, the sample size for the questionnaire survey was changed to

Table 1
Sleep patterns during the stay-at-home conditions questionnaire that was used in the current survey.

Sleep patterns during the stay-at-home conditions questionnaire that was used in the current survey.

Sleep patterns during stay-at-home conditions questionnaire.

Please fill this questionnaire IF you are 15-60 years old, are in quarantine or other stay-at-home conditions for 14 days or more, had no previous chronic diseases, sleep disorders, and sleep-related complaints, do not take sleeping pills, did not work night shifts, and are not currently involved in online teaching, learning, work-from-home and other daily schedule/timetable-related activities.
Please DON'T FILL this questionnaire if you had any sleep disorders before the quarantine (sleepiness, wakefulness (insomnia), sleep apnea, etc.), take sleeping pills, or if you are involved in online teaching, learning, work-from-home and other daily schedule/timetable-related activities during the stay-at-home period. Pregnant women should not fill the questionnaire.

If your stay-at-home condition is prolonged, please fill this questionnaire again after 1 month at home and 2 months at home.

Q1. Age: Q2. Sex: Q3. Days in stay-at-home:

Before the stay-at-home situation.
Q4. Did you use a morning alarm clock regularly? YES NO (Highlight the answer)

For alarm user:

Q5. When did you go to bed regularly? Time: _____

Q6. When did you go to bed during weekends, holidays, vacation? Time: _____

Q7. When did you wake up with the morning alarm? Time: _____

Q8. When did you wake up without the morning alarm (weekends, holidays)? Time:_____

Q9. Did you practice midday napping/siesta regularly? YES NO

Q9a. If YES, specify the time (from – till) or for how long: _____

No morning alarm:

Q5a. When did you go to bed regularly? Time: _____

Q6a. When did you usually wake up in the morning? Time: _____

Q9a. Did you practice midday napping/siesta regularly? YES NO

Q9b. If YES, specify the time (from – till) or for how long: _____

During the current stay-at-home situation.

Q10. Do you still use the morning alarm clock regularly? YES NO (Highlight the answer)

Q10a. If YES, did you change your sleep duration? How? _____

Stay-at-home for 14 days, no morning alarm:

Q11. When do you go to bed regularly? Time: _____

Q12. If you go to bed in different times, specify the main pattern: _____

Q13. When do you usually wake up in the morning? Time: _____

Q14. Do you currently practice midday napping/siesta regularly? YES NO

Q14a. If YES, specify the time (from – till) or for how long: _____

Q15. In general, how many times do you sleep daily now? ONCE TWICE THREE times

Stay-at-home about a month:

Q16. When do you go to bed regularly now? Time: _____

Q17. If you go to bed in different times, specify the main pattern: _____

Q18. When do you usually wake up in the morning? Time: _____

Q19. Do you currently practice midday napping/siesta regularly? YES NO

Q19a. If YES, since when? Day: _____

Q19b. If YES, specify the time (from – till) or for how long: _____

Q20. In general, how many times do you sleep daily now? ONCE TWICE THREE times

Stay-at-home about two months:

Q21. When do you go to bed regularly now? Time: _____

Q22. If you go to bed in different times, specify the main pattern: _____

Q23. When do you usually wake up in the morning? Time: _____

Q24. Do you still currently practice midday napping/siesta regularly? YES NO

Q24a. If YES, since when? Day: _____

Q24b. If YES, specify the time (from – till) or for how long: _____

Q25. In general, how many times do you sleep daily now? ONCE TWICE THREE times

Q26. Any other remarks on your current sleep pattern changes are welcome: _____

10,000 (the margin of error ˂ 1%) and the sample size for the simplified log survey was changed to 3000 (the margin of error 1.8%). The extended log and the interview cohorts were kept at 500.

2.3. Data collection

The data were collected in the USA, the UK, Australia, Canada, Israel, Germany, France, Ukraine, Russia, India, and Uzbekistan. Since March 1, the pilot project began and since March 15, when several countries went in a full stay-at-home or "lock-down" condition, the full study was implemented. The data were collected until the end of May. The pyramid system of data collection ("snowball sampling technique") was designed. The primary investigators had spread the survey tools in a friend-to-friend manner, to the collaborators, through an online forum, and via Internet social networks. The collaborators repeated the same procedure country-specific. After that, further dissemination of the questionnaire and the simplified log became uncontrollable contact to contact or online activity. A volunteer had a choice either to fill the questionnaire or to keep the log. The returning of the filled forms was done in the same pyramid manner. The survey was anonymous and all personal data, except age and sex, were not included in the data spreadsheets. Following the Ethics Committees regulations, while the study used mostly online-manner survey, the confidentiality of the participants was maintained in compliance with the requirements of the Data Protection Act 1998 and the subsequent General Data Protection Regulation (GDPR). All investigators, their collaborators in the countries, and study site staff complied with the requirements of the Data Protection Act 1998 and GDPR concerning the collection, storage, processing and disclosure of personal information and upheld the Act's core principles. This included the creation of depersonalized data spreadsheets, secure maintenance of information, with access limited to the minimum number of individuals necessary for quality control, audit, and analysis. At the end of the study, the online forums and other Internet-related survey activities were immediately terminated.

The detailed log instructions were distributed separately by the investigators in the USA, the UK, and Israel. Phone/Skype interviews were conducted in the USA and Israel.

The collection of the filled questionnaires was terminated when 10,000 filled forms qualified for further analysis were collected. By selecting the forms, preference was given to the forms that were kept for a longer time. The filled forms with ambiguous answers (multiple responses for a single question, "unsure" answers, questions left blank, etc.) were excluded from the analysis. The collection of the simplified daily logs was terminated when 3000 filled forms qualified for further analysis were collected. As for the questionnaire, preference was given to the logs that were kept for a longer period. The participants could select either the questionnaire form of the survey or the simplified log by their own choosing, but only one tool could be selected by a participant. The extended log forms were offered to 1000 volunteers but the properly filled logs arrived only from 543 participants and 500 logs being kept for a longer time were selected. The interviews were conducted among 500 volunteers as planned. At least four weekly interviews should be collected from each participant.

The prospective study was approved by the responsible Ethics Committees as a "non-interventional anonymous survey of volunteers" (USA: AMIIE-2020-Mar-3/04; Israel: AMHSI-2020-Mar-1/02; Uzbekistan: TashSMU -64.3-39, March 15, 2020; Russian Federation: Crimean Federal University, March 15, 2020; Ukraine: DHMedUn-839/20, March 18, 2020). We followed the recommendations of the 1975 Declaration of Helsinki (amended 2013).

2.4. Analysis

Descriptive analysis was provided to describe basic and general information about the demographic and specific question results. The results include the distribution of survey participants by age and sex classifications. In most cases, the categorical data specific to the amount of sleep obtained was ordinal.

Sleep duration and sleep patterns data were analyzed using univariate analyses of covariance (ANCOVA) with age group and gender as fixed factors. The difference between "time in bed" and "total sleep time" was taken into account. The questionnaires and logs reported time in bed because no one can record when he/she fell asleep. The difference between these two conditions was established to be 10% on average [12,15,16]. The initial step of the statistical analysis of sleep duration included the 10% reduction from the reported numbers. We used one-way analysis of variance (ANOVA) to compare the data from three age groups (df1 = 2, df2a = 13,999, df2b = 12,380). Within the same group, the longitudinal analysis (before stay-at-home, two weeks, one months, and two months of stay-at-home) was performed by repeated-measures ANOVA (df1 = 3, df2a = 13,999, df2b = 12,380).

Three main time-related variables were assessed: V1 – evening bedtime, V2 – morning get-up time, and V3 – total sleep duration (including possible naps). For V1 and V2, four main-phase variations were assessed for pre-lockdown situation (V1a and V2a), two weeks of stay-at-home (V1b and V2b), one month (V1c and V2c), and two months (V1d and V2d) of the stay-at-home. The data for these two variables were collected the following way: from questionnaires – n of participants x 2–3 (for two weeks, one month, and two months responses), from daily logs - n of participants x n of the days of stay-at-home, from interviews - n of participants x 6–8 interview sessions. V1a,b and V2a,b were collected from all 14,000 volunteers. The data on the napping duration was obtained from nap-specific questions, items in the logs, and during interviews. After all this information was collected from the participants, V3a,b,c,d were calculated.

While decimal statistics does not apply to minutes, SPSS TIME.HMS function was applied. Chi-square tests were used to analyze age and gender distribution and the questionnaire or log responses for differences in sleep habits distribution between groups. The correlation analysis (r value) was performed between V1, V2, and total sleep duration (V3) and age and sex. The correlation of presence/absence of regular naps was also performed against these two fixed factors. The r˃0.60 was counted as the significant correlation. All statistical analyses were performed using SPSS (version 19.0, SPSS Inc., Chicago, IL). A significance threshold of p˂0.05 was used for all analyses.

3. Results

Data on home sleep habits were analyzed for the 14,000 subjects (Tables 2 and 3). The average stay-at-home for the whole cohort was 62 days, mainly between March 15 and May 15. The sleep habit-related data were derived from the logs (n = 3500; the margin of error 1.7% at a 95% confidence interval; 3500 × 62 days = 217,000 responses for V1 and V2), interviews (n = 500, the margin of error 4.4%; 500 × 7 or 8 interviews = 3872 responses), and daily pattern-related filled questionnaires (n = 10,000, the margin of error ˂1%; 10,000 × 2 or 3 filled parts = 29,670 responses), and 14,000 cases with sufficient data were analyzed. The agreements between the data collection tools were: the logs vs. the interviews – 97.8% agreement; the log vs. the questionnaires – 94.4%; and for the interviews vs. the questionnaires 96.5% of agreement were obtained. For V1a,b and V2a,b 14,000 responses were collected for each of the variable. For V1c and V2c, 13,447 responses were collected, and for V1d and V2d 12,381 responses were collected (Table 3). The total number of responses collected for V1 and V2 during the whole time of the survey was 250,542 for each of them.

Before stay-at-home, the average time in bed was 7:50 ± 0:35 that corresponds to the total sleep time of 7:03. While 2308 of participants used regular napping, it added additional 16 min of sleep thus presenting the average total sleep time of 7:19 for the whole cohort. The prolonged sleep during weekends added another 17 min per day if divided for the whole week thus presenting the average total sleep time of 7:36 ± 0:34 for a week (range: 5:15–10:50). The sleep duration data

Table 2
Demographic and general data of the surveyed cohort (n = 14,000) obtained from filled questionnaire forms, daily logs, and during interviews. M/F – male/female.

Variables↓/age groups→	15–18 y.o.	19–39 y.o.	40–60 y.o.		Total/average				
Questionnaire M/F		1374/984	1966/1510	1740/2426		10,000			
Simple log M/F		239/251	358/612	732/808		3000			
Detailed log M/F		52/64		63/81		117/123		500	
Interview M/F			75/39		80/61		107/138		500
Age group M/F TOTAL	1740/1338	2467/2264	2696/3495		6903/7097				
Age group TOTAL		3078		4731		6191			14,000
Average stay-at-home	66 days	53 days	62 days		62 ± 8 days				

Table 3
Data on sleep habits before and during the stay-at-home. Actual responses are presented. During the analysis, 10% of the time was deducted to turn "time in bed" into actual "total sleep time". Standard deviations are given in brackets. "Total sleep time" includes naps.

Variables↓/age groups→	15–18 y.o.	19–39 y.o	40–60 y.o.		Average	
Before stay-at-home (obtained from 14,000 participants)						
V1a. Evening bedtime		22:15 (0:20)	23:12 (0:22)	22:20 (0:20)		22:23 (0:45)
V2a. Morning get-up time	06:50 (1:00)	07:00 (0:45)	07:15 (0:34)		07:10 (0:38)	
Weekend bedtime		23:23 (0:40)	23:55 (0:50)	23:55 (0:52)		23:37 (0:50)
Weekend get-up time		8:50 (0:45)	8:50 (0:40)	8:40 (0:44)		8:46 (0:45)
V3a. Total sleep time		8:36 (0:24)	7:24 (0:17)	7:33 (0:40)		7:36 (0:34)
14 days stay-at-home (obtained from 14,000 participants)						
V1b. Evening bedtime	23:30 (1:07)	23:55 (0:50)	23:45 (0:50)		23:44 (0:55)	
V2b. Morning get-up time	8:50 (1:15)	8:50 (0:55)	8:40 (0:55)		8:48 (1:13)	
V3b. Total sleep time		9:25 (1:12)	8:22 (0:55)	8:46 (0:57)		8:52 (1:07)
1 month stay-at-home (obtained from 13,447 participants)						
V1c. Evening bedtime		23:54 (1:18)	23:55 (0:50)	23:35 (0:50)		23:44 (1:03)
V2c. Morning get-up time	9:00 (1:22)	8:54 (0:55)	8:45 (1:05)		8:55 (1:11)	
V3c. Total sleep time		9:08 (1:25)	8:14 (0:58)	8:55 (1:10)		8:53 (1:13)
2 months stay-at-home ((obtained from 12,381 participants)						
V1d. Evening bedtime	23:55 (1:15)	24:05 (0:50)	23:15 (1:20)		23:43 (1:10)	
V2d. Morning get-up time	9:00 (1:25)	8:55 (0:55)	8:12 (1:16)		8:36 (1:18)	
V3d. Total sleep time		9:34 (1:20)	8:20 (1:00)	9:12 (1:27)		9:10 (1:16)

obtained from the questionnaires and the logs were almost identical ($p = 0.93$) and the questionnaire and the log types of the survey were cross-validated.

The most significant changes in sleep habits occurred during the first 14 days of stay-at-home; the first week was the most critical. The difference in the sleep duration between weekdays and weekends disappeared. Most of the participants discontinued using alarm clocks. Table 3 indicates that the total sleep time increased in duration up to 8:52 ± 1:07 (+1:16 against pre-stay-at-home condition, $p = 0.03$) after the first 14 days with a subsequent increase to 9:10 ± 1:16 to the end of the quarantine/stay-at-home (+1:34, $p = 0.02$). The age-dependent changes in napping habits occurred. In general, daily temporal patterns and sleep habits of the majority of the participants underwent significant changes that were developing further during a prolonged stay-at-home condition. According to the data extracted during interviews and from questions Q12, Q17, Q22, and Q26 of the questionnaire, only 184 participants (1.8% from 10,500) indicated the appearance of insomnia during the first 14-day period. This amount dropped to 37 participants (0.5%) after two months of stay-at-home. Another 38 participants (0.5%) indicated their sleep pattern as "unusual" without further clarification.

3.1. Age-dependent changes

Group 1 was the smallest group of the participants because many high school students were engaged in various Zoom-related scheduled educational activities. Before stay-at-home, the absolute majority of the participants used alarm clocks, and about one-third of them, mainly girls, practiced midday napping (Tables 4 and 5). The wake-up time was the most variable in this group with one-hour standard deviation because bell schedules in different high schools were set for the first bell from 6:30 a.m. to 10:00 a.m. as extremes and from 7:15 a.m. to 8:40 as a general pattern. Table 3 indicates that to the end of the stay-at-home period, the sleep duration of the adolescents was 58 min longer than during the pre-quarantine period (9:34 ± 0:24 vs. pre-stay-at-home 8:36 ± 1:20; $p = 0.05$) and Table 5 shows that the number of nap users significantly decreased. Before stay-at-home, the sleep duration of 586 adolescents (19%) was less than 8 h. This number dropped to 47 (1.5%) after two months of the stay-at-home.

Group 2 participants remained relatively stable in their daily patterns if compared with the adolescents, but their sleep duration also increased from 7:24 ± 0:17 to 8:20 ± 1 h (+56 min, $p = 0.05$. Before stay-at-home, the sleep duration of 1011 younger adults (21.4%) was less than 7 h. This number dropped to 229 (4.8%) after two months of the stay-at-home.

The Group 3 participants increased their sleep duration from 7:33 ± 0:40 to 9:12 ± 1:27 (+1:49, $p = 0.02$) and the number of nap users was significantly increased. Before stay-at-home, the sleep duration of 1148 older adults (18.5%) was less than 7 h. This number dropped to 117 (1.9%) after two months of the stay-at-home. No sex-related correlations were detected except that girls of Group 1 used napping more often before the stay-at-home ($r = 0.66$) and that Group 3 males used napping more often during the stay-at-home ($r = 0.70$).

3.2. Morning alarms

Before the stay-at-home, 74.1% of all respondents used morning alarms (Table 4). For Group 1, this percentage was 93.2. During the first 14 days of the stay-at-home, this percentage was reduced to 20.6 ($p = 0.0003$) (24% for Group 1, $p = 0.0005$), and after two months in quarantine, 17.7% of all respondents still used an alarm clock (Group 1:

Table 4
The alarm clock-related data of the survey. The number of alarm users is given against the total number of participants in each age group. Standard deviations are presented in brackets.

Variables↓/age groups→	15–18 y.o.	19–39 y.o	40–60 y.o.		Total; Average	
Before stay-at-home (obtained from 14,000 participants)						
Used morning alarm (n)	2867/ 3078	3362/ 4731	4145/ 6191		10,374/ 14,000	
Get-up time with alarm	6:30 (0:45)	6:30 (0:55)	6:30 (1:03)		6:30 (0:56)	
Sleep duration alarm users	8 h (0:30)	7 h (0:35)	6:40 (0:36)		7 h (0:44)	
Sleep duration w/o alarm	9 h (0:20)	8 h (0:22)	8:10 (0:35)		8:20 (0:40)	
14 days stay-at-home (obtained from 14,000 participants)						
Used morning alarm (n)	739/ 3078	922/ 4731	1218/ 6191		2879/ 14,000	
Get-up time was the same	118/ 3078	563/ 4731	821/ 6191		1502/ 14,000	
New get-up time (n)		621/ 3078	359/ 4731	397/ 6191		1377/ 14,000
New get-up time (h)		8:00 (0:15)	8:00 (0:20)	7:40 (0:25)		7:54 (0:20)
1 month stay-at-home (obtained from 13,447 participants)						
Used morning alarm (n)	358/ 3003	872/ 4514	940/ 5930		2093/ 13,447	
New get-up time w/alarm	8:00 (0:15)	8:00 (0:15)	8:00 (0:25)		8:00 (0:20)	
2 months stay-at-home ((obtained from 12,381 participants)						
Used morning alarm (n)	287/ 3000	596/ 4262	732/ 5119		1701/ 12,381	
New get-up time w/alarm	8:00 (0:15)	8:00 (0:25)	8:10 (0:25)		8:05 (0:25)	

9.6%). Among the continuous users, about half did not change their wake-up time, while another half set the alarm to later hours. Only 10.7% of the whole cohort kept the wake-up time constant ($n = 1502$). The information derived from interviews and free-response survey question (Q26) ($n = 97$) indicated that main reasons to keep the alarm-related wake-up time unchanged were little children at home ($n = 33$, 34%), morning prayers ($n = 26$, 26.8%), and pets ($n = 14$, 14.4%), while only 12 respondents (12.4%) indicated the "force of habit" as the main reason. The rest of 12.4% of the users indicated sports activities, family duties, and personal reasons to keep an alarm. The participants who changed the alarm time ($n = 1377$) usually set the alarm hour ahead for 1 h or 1 h 30 min.

3.3. The napping patterns

Before the stay-at-home, 16.5% of all respondents practiced napping regularly (Table 5). In Group 1, 36.3% practiced napping regularly while only 7.5% of young adults (Group 2) indicated this habit ($p = 0.002$). For Group 3, 13.5% practiced napping ($p = 0.006$ against adolescents) with longer napping duration. The correlation with the female gender ($r = 0.66$) was found in Group 1 and the correlation with the male gender ($r = 0.67$) in Group 3. During the first 14 days of stay-at-home, the number of nap-users among adolescents dropped to 8.6% ($p = 0.003$) with a subsequent decline to 7.1% after two months irrespective to their sex. In Group 2, the percentage of nap-users increased to 10% during the first 14 days with slow further growth to 11.3% after two months of stay-at-home. In Group 3, this tendency was more significant when 20.2% of the participants introduced napping in their daily life during the 14 days of the stay-at-home period with a subsequent increase of this percentage to 29.2% after the two-month period ($p = 0.04$). More than one nap per day was a very rare habit for the participants during the first 14 days of stay-at-home (0.2%). After two months of stay-at-home, 1% of the respondents practiced two or more naps a day ($p = 0.03$).

4. Discussion

Our results that describe sleep duration and sleep timing of healthy individuals in a pre-quarantine environment are in concord with the previously reported data [9–13,16]. The main part of our results indicates that both the duration and timing of sleep of stay-at-home individuals significantly differ from those of socially and economically predesigned daily routine conditions. The changes in sleep duration were beneficial. For example, the recommended amount of nocturnal sleep for adolescents was estimated as eight to 10 h [17,18]. The emerging literature reported that from 18% to one-third of adolescents got insufficient sleep during normal life [17,19–21]. During stay-at-home, the sleep duration of the majority of our participants in all age groups complied with the NSF recommendations [13,14,17,18], and the absolute majority of the participants had sleep duration within "recommended" (8–10 h for adolescents, 7–9 h for adults) and "may be appropriate" (7–12 h for adolescents, 6–10 h for adults) definitions.

The COVID-19-pandemic-related article reported the results of a short-term mental health survey of 662 respondents in India [22]. Of them, 12% reported "sleeping difficulty" without further clarification. The report, however, was not stay-at-home-specific and no inclusion/exclusion criteria were reported except that the participants were adults. Another COVID-19-related article reported the status of individuals with previously diagnosed insomnia during the quarantine [23]. The authors found that "some individuals with elements of behaviorally insufficient sleep are now able to extend their sleep opportunity and see an improvement in sleep". We fully confirm this statement. Our results indicate that situation-related insomnia is possible but it is short-term and rare for healthy individuals. The prolonged stay-at-home condition leads mainly to mild sleepiness.

The extensive use of alarm clocks in daily routine raised a question of "social jet-lag" [24]. The problem of sleep debt accumulated on workdays also was well-understood [25]. The absolute majority of humans discontinue using alarm clocks when they have a chance if the free daily schedule and self-selected sleep are possible.

Napping is a natural habit for infants and young children [26,27]. Our results indicate two sex and age-specific groups of nap users: adolescent girls and older adult males. The girls used napping frequently during the pre-quarantine period. Being forced to get up early in the morning for school, they took naps either before or after meals coming back home. This habit almost disappeared during stay-at-home due to a free-running daily rhythm. In contrast, the habit of napping was increased among the older stay-at-home males. Many of them were involved in work-from-home activities that were not schedule-related and they were free to select their timing for these activities. While naps often were prolonged, the nocturnal sleep was shorter and with easy early morning wake-ups; but desired eight to nine hours of daily sleep were easily achieved.

The stay-at-home sleep habits are connected with another topic that became acute during the current COVID-19 pandemic, namely, work-from-home issue. The pandemic has dramatically increased the importance of working from home, but presented the problem of workers

Table 5
The data of the survey related to napping. The number of nap users is given against the total number of participants in each age group. Standard deviations are presented in brackets.

Variables↓/age groups→	15–18 y.o.	19–39 y.o	40–60 y.o.	Total;Average		
Before stay-at-home (obtained from 14,000 participants)						
Regular napping (n)		1117/3078	355/4731	836/6191	2308/14,000	
Napping bedtime		16:00 (0:30)	17:00 (0:30)	14:00 (1:00)	15:45 (0:50)	
Napping duration		1 h (0:30)	1 h (0:30)	2 h (1:00)	1 h 40 m	
14 days stay-at-home (obtained from 14,000 participants)						
Regular napping (n)		265/3078	472/4731	1250/6191	1987/14,000	
Napping bedtime		16:00 (0:45)	17:00 (0:30)	15:00 (1:00)	15:40 (1:00)	
Napping duration		2 h (1:00)	2 h (1:00)	2:30 (1:00)	2:40 (1:00)	
More than one nap		0		0	32/6191	32/14,000
1 month stay-at-home (obtained from 13,447 participants)						
Regular napping (n)		229/3003	486/4514	1367/5930	2082/13,447	
Napping bedtime		16:00 (1:00)	17:00 (1:00)	14:00 (1:50)	3:15 (1:15)	
Napping duration		2 h (1:00)	2 h (1:00)	3 h (0:30)	2:50 (0:45)	
More than one nap		3/3003	9/4514	86/5930	98/13,447	
2 months stay-at-home ((obtained from 12,381 participants)						
Regular napping (n)		213/3000	483/4262	1494/5119	2190/12,381	
Napping bedtime		15:00 (1:00)	16:00 (1:00)	15:00 (2:00)	15:20 (1:00)	
Napping duration		2 h (1:00)	2 h (1:00)	3 h (0:30)	2:50 (0:40)	
More than one nap		6/3000	19/4262	112/5119	137/12,381	

adapting to new conditions and the problem of management in such a situation. In Europe and Australia, the number of people working from home has increased 4–5 times since the start of the pandemic [28,29]. Verma & Gustafsson (2020) recommend companies to "embrace remote work", but do not provide guidelines on how to do this [30]. Carnevale & Hatak (2020) point out that working from home can disrupt the family-work balance, blur the line between home and work, and cause stress [31]. Hoffman et al. indicate the positive impact of working from home: more time with family, no travel, flexible working hours [32]. There are three options regarding the work schedule: 1) a tight work schedule - the employee at home must work the same hours as at work; 2) almost free schedule with 1 h for a Zoom meeting every day; 3) free schedule - the employee knows what needs to be done and how quickly, but can choose the hours when to work. The results of the current study and of our study dedicated to sleep timing issues [33] demonstrate that workers who worked free hours during lockdown did not complain about their condition.

NSF and the Evelina London sleep team presented guidelines and sleep tips for persons caught in the COVID-19 pandemic [34,35]. They recommended using an alarm to have a fixed time to get-up every day, "sticking to the normal wake and sleep times as much as possible," and to avoid long naps. It means that the experts in sleep medicine precisely predicted the sleep-related changes that might occur during stay-at-home. Our results indicate that the majority of stay-at-home individuals did not seem to follow these recommendations.

While a questionnaire-based survey is an established technique to study sleep patterns, any self-report survey has its limitations. This problem was partially overcome by a large cohort of respondents, yet the studies involving digital sleep-tracking devices, wrist-activity monitors, and other portable actigraphic devices may produce more precise results. The geographical analysis was not performed because of the significantly uneven distribution of respondents across the involved countries. Our cohort included only healthy individuals aged 15–60 and our results cannot be generalized to the whole human population that may include individuals with sleep disorders, mood-related disorders, pregnant women, and individuals older than 60 years. Our results cannot be generalized to the individuals involved in education/work-from-home activities that required them to keep pre-quarantine timetables.

During stay-at-home conditions, both duration and timing of sleep significantly differ from those of socially and economically predesigned daily routine and most humans sleep longer than in a schedule-dependent operational environment. An appearance of anxiety-induced insomnia is extremely rare if an individual is already in the stay-at-home situation.

Authors contributions

MS and AMHSI RT conceived the study and its design, had full access to the data, and take responsibility for the integrity of the data and accuracy of the analysis. MS, AMHSI RT, and MRT designed the methodology. MS, AMHSI RT, MRT, JB, AL, LN, GSU, VK, SK, and NB conducted the survey, collected data, organized, and entered the data. MS, AMHSI RT, and YR contributed to data analyses. MS, AMHSI RT, MRT, YR, and VK contributed to data interpretation. AMHSI RT drafted the manuscript. MS and YR prepared the final version of the manuscript. All authors critically revised the drafted manuscript and approve of the submitted manuscript.

Funding

The study was supported by AMHSI-AMIIE (USA - Israel) without any external financial support.

Declaration of Competing Interest

All authors have completed the ICMJE uniform disclosure form at www.icmje.org/coi_disclosure.pdf and declare that they have no competing interests.

Acknowledgments

AMHSI Research Team consisted of Orit Rome, Leor Sinai, Rachelle Sevitt, Ayela Meroody, Marnie Nadolne, Psy.D., ORCID # 0000-0002-6259-6722, Jeanne Lombroso, Philip Shilco, DMD, Geoffrey P. Jacobs, Ph.D., Caitlin Elkington Levy, and Michael Shterenshis, MD, who equally contributed to the project.

Milken Research Team consisted of Abby Sosnow, Maya Foonberg, Elijah Faridnia, Ariel Emrani, Liana Hiekali, Mika Cohen, Candice Shohed, Taylor Golshan, and Kaitlyn Nickfardjam who equally contributed to the project.

The authors acknowledge their collaborators, assistants, and aids in the following countries:

USA: Alex Lasky, Sarah Shulkind, Ph.D., Kimberly Schwarz, Sari Rosenberg, Jacob Ilani, Ruby Stillman, David Khabie, Tatum Mayo, Sabrina Cohensedgh, Eden Frig-Levinson, Anna Volynsky-Lauson, Michael Schmitz, Kayla Dadbin, Sarah Lande, Camden Permaul, Charles Frank, Pauline Kim. UK: Paul Corby, Paul Wasson, Christopher

Brook, Julia Fentiman, Luke Foley. Australia: Antony Morgan, MD, ORCID # 0000-0003-4142-5622; Aaron Kavin, Ryan Cleminson, Edan Schonberger. Israel: Hepzibah Alon, Mordechai Cohen, Monika Singer, Michele Annis, Lisa Biton, Brian Frank, Esther Fellman, Tasha Elliston, Ryan Higgins, Adee Benartzy, Debby Mir, Ph.D. Germany: Volker Imhof, Helena Hungele. France: Tatiana Koriche-Shamrai. Ukraine: Khrystyna Predko. Russian Federation: Kadri Mametov, MD, ORCID # 0000-0001-6432-9313; Lutfie Mametova, MD, Tatiana Karasova, Ph.D. Uzbekistan: Nigora Z. Nazarova, MD.

The authors thank most sincerely all the volunteers in different countries who invested their time and effort in the current project.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpsychores.2020.110282.

References

[1] N. Jacobson, D. Lekkas, G. Price, et al., Flattening the Mental Health Curve: COVID-19 Stay-at-Home Orders are Associated With Alterations in Mental Health Search Behavior in the United States, JMIR Ment. Health, 2020, https://doi.org/10.2196/19347.
[2] S. Lee, L.Y. Chan, A.M. Chau, K.P. Kwok, A. Kleinman, The experience of SARS-related stigma at Amoy Gardens, Soc. Sci. Med. 61 (9) (2005) 2038–2046.
[3] C. DiGiovanni, J. Conley, D. Chiu, J. Zaborski, Factors influencing compliance with quarantine in Toronto during the 2003 SARS outbreak, Biosecur. Bioterror. 2 (4) (2004) 265–272.
[4] A. Desclaux, D. Badji, A.G. Ndione, K. Sow, Accepted monitoring or endured quarantine? Ebola contacts' perceptions in Senegal, Soc. Sci. Med. 178 (2017) 38–45, https://doi.org/10.1016/j.socscimed.2017.02.009.
[5] World Health Organization, Mental health and COVID-19. http://www.euro.who.int/en/health-topics/health-emergencies/coronavirus-covid-19/novel-coronavirus-2019-ncov-technical-guidance/coronavirus-disease-covid-19-outbreak-technical-guidance-europe/mental-health-and-covid-19, 2020 (accessed 22 May 2020).
[6] S.K. Brooks, R.K. Webster, L.E. Smith, et al., The psychological impact of quarantine and how to reduce it: rapid review of the evidence, Lancet 395 (10227) (2020) 912–920, https://doi.org/10.1016/S0140-6736(20)30460-8.
[7] E. Binns, The Anatomy of Sleep, John Churchill, London, 1845.
[8] M. De Manacéíne, Sleep: Its Physiology, Pathology, Hygiene, and Psychology, Walter Scott, Ltd., London, 1897.
[9] E.O. Bixler, A. Kales, J.A. Jacoby, C.R. Soldatos, A. Vela-Bueno, Nocturnal sleep and wakefulness: effects of age and sex in normal sleepers, Int. J. Neurosci. 23 (1) (1984) 33–42.
[10] V. Brezinova, The number and duration of the episodes of the various EEG stages of sleep in young and older people, Electroencephalogr. Clin. Neurophysiol. 39 (3) (1975) 273–278.
[11] K.L. Knutson, E. Van Cauter, P.J. Rathouz, T. DeLeire, D.S. Lauderdale, Trends in the prevalence of short sleepers in the USA: 1975–2006, Sleep 33 (2010) 37–45.
[12] S.D. Youngstedt, E.E. Goff, A.M. Reynolds, et al., Has adult sleep duration declined over the last 50+ years? Sleep Med. Rev. 28 (2016) 69–85, https://doi.org/10.1016/j.smrv.2015.08.004.
[13] National Sleep Foundation, Sleep in America Poll: Adult Sleep Habits and Styles 2005, National Sleep Foundation, Washington, DC, 2005.
[14] National Sleep Foundation, Sleep Diary/Sleep Log. www.sleepfoundation.org, 2020 (accessed 20 March 2020).
[15] K.A. Cote, C.E. Milner, B.A. Smith, et al., CNS arousal and neurobehavioral performance in a short-term sleep restriction paradigm, J. Sleep Res. 18 (3) (2009) 291–303.
[16] E.O. Bixler, M.N. Papaliaga, A.N. Vgontzas, et al., Women sleep objectively better than men and the sleep of young women is more resilient to external stressors: effects of age and menopause, J. Sleep Res. 18 (2) (2009) 221–228.
[17] M. Hirshkowitz, K. Whiton, S.M. Albert, et al., National sleep foundation's sleep time duration recommendations: methodology and results summary, Sleep Health 1 (1) (2015) 40–43, https://doi.org/10.1016/j.sleh.2014.12.010.
[18] M. Hirshkowitz, K. Whiton, S.M. Albert, et al., National sleep foundation's updated sleep duration recommendations, Sleep Health 1 (4) (2015) 233–243, https://doi.org/10.1016/j.sleh.2015.10.004.
[19] J.P. Chaput, I. Janssen, Sleep duration estimates of Canadian children and adolescents, J. Sleep Res. 25 (5) (2016) 541–548, https://doi.org/10.1111/jsr.12410.
[20] K.A. Patte, W. Qian, S.T. Leatherdale, Sleep duration trends and trajectories among youth in the COMPASS study, Sleep Health 3 (5) (2017) 309–316, https://doi.org/10.1016/j.sleh.2017.06.006.
[21] S.V. Bauducco, I.K. Flink, M. Jansson-Fröjmark, S.J. Linton, Sleep duration and patterns in adolescents: correlates and the role of daily stressors, Sleep Health 2 (3) (2016) 211–218, https://doi.org/10.1016/j.sleh.2016.05.006.
[22] D. Roy, S. Tripathy, S.K. Kar, N. Sharma, S.K. Verma, V. Kaushal, Study of knowledge, attitude, anxiety & perceived mental healthcare need in Indian population during COVID-19 pandemic, Asian J. Psychiatr. 51 (2020) 102083, https://doi.org/10.1016/j.ajp.2020.102083.
[23] N. Simpson, R. Manber, Treating insomnia during the COVID-19 pandemic: observations and perspectives from a behavioral sleep medicine clinic, Behav. Sleep Med. (2020), https://doi.org/10.1080/15402002.2020.1765781.
[24] M.L. Phillips, Circadian rhythms: of owls, larks and alarm clocks, Nature 458 (7235) (2009) 142–144, https://doi.org/10.1038/458142a.
[25] T. Roenneberg, A. Wirz-Justice, M. Merrow, Life between clocks: daily temporal patterns of human chronotypes, J. Biol. Rhythm. 18 (1) (2003) 80–90.
[26] A. Araki, J. Ohinata, N. Suzuki, et al., Questionnaire survey on sleep habit of 3-year-old children in Asahikawa City, No To Hattatsu 40 (5) (2008) 370–374.
[27] J.P. Chaput, C.E. Gray, V.J. Poitras, et al., Systematic review of the relationships between sleep duration and health indicators in the early years (0-4 years), BMC Public Health 17 (Suppl. 5) (2017) 855, https://doi.org/10.1186/s12889-017-4850-2.
[28] M.J. Beck, D.A. Hensher, E. Wei, Slowly coming out of COVID-19 restrictions in Australia: implications for working from home and commuting trips by car and public transport, J. Transp. Geogr. 88 (2020) 102846, https://doi.org/10.1016/j.jtrangeo.2020.102846.
[29] J. Prochazka, T. Scheel, P. Pirozek, et al., Data on work-related consequences of COVID-19 pandemic for employees across Europe, Data Brief 32 (2020) 106174, https://doi.org/10.1016/j.dib.2020.106174.
[30] S. Verma, A. Gustafsson, Investigating the emerging COVID-19 research trends in the field of business and management: a bibliometric analysis approach, J. Bus. Res. 118 (2020) 253–261, https://doi.org/10.1016/j.jbusres.2020.06.057.
[31] J.B. Carnevale, I. Hatak, Employee adjustment and well-being in the era of COVID-19: implications for human resource management, J. Bus. Res. 116 (2020) 183–187, https://doi.org/10.1016/j.jbusres.2020.05.037.
[32] K.E. Hoffman, D. Garner, A.C. Koong, W.A. Woodward, Understanding the intersection of working from home and burnout to optimize post-COVID19 work arrangements in radiation oncology, Int. J. Radiat. Oncol. Biol. Phys. 108 (2) (2020) 370–373, https://doi.org/10.1016/j.ijrobp.2020.06.062.
[33] Y. Roitblat, J. Burger, M. Vaiman, et al., Owls and larks do not exist: COVID-19 quarantine sleep habits, Sleep Med. S1389-9457 (20) (2020) 30406–30408, https://doi.org/10.1016/j.sleep.2020.09.003.
[34] National Sleep Foundation, Sleep Guidelines During the COVID-19 Pandemic, SLEEPFOUNDATION.ORG, 2020. https://www.sleepfoundation.org/sleep-guidelines-covid-19-isolation (accessed 20 May 2020).
[35] Evelina London Sleep Team, Coronavirus (COVID-19) Sleep Tips for Families, Guy's and St Thomas' NHS Foundation Trust, 2020. https://www.evelinalondon.nhs.uk/our-services/hospital/sleep-medicine-department/coronavirus-sleep-tips.aspx (accessed 20 May 2020).