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Original Article

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Relaxation of social time pressure reveals tight coupling between daily sleep and eating behavior and extends the interval between last and first meal

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Abstract

Study Objectives: As a day-active species, humans abstain from some or all foods and beverages and rest at night. The modern social clock diverged from the natural light–dark clock with far-stretching consequences for both fasting/eating and sleep/wake daily cycles.
Methods: During the COVID-19 pandemic, prolonged social restrictions (SRs) offered a quasi-experimental protocol to directly test the impact of the relaxed social clock on eating and sleep behaviors and the coupling between them.
Results: Using data from a global survey of 5747 adults (mean age 37.2 ± 13.7, 67.1% females, 100% worked/studied), we show that relaxation of the social time pressure (STP) during SRs led, on average, to a 42 min increase in the habitual fasting duration (FD, interval between the last and the first meal) (from 12:16 ± 2:09 to 12:57 ± 2:04) and a 34 min delay in the fasting window. FD was extended by lengthening both the presleep fasting and sleep durations. Pre-SR breakfast eaters delayed sleep and fasting, while breakfast skippers delayed sleep and advanced meals. Stopping alarm use on workdays was associated with a larger increase in FD. The correlations between chronotype, FD, and the mid-fasting time became more robust during SR.
Conclusions: We conclude that relaxed STP extends habitual FD and promotes co-alignment of daily fasting and sleeping. Given the finding that the sleep-fasting phase relationship during SRs remained stable, we suggest that a "daily sleep-fasting structure" may be a novel circadian marker quantifying the coupling between daily rhythms. These results may inform strategies of public circadian health management.

Key words: circadian rhythms; nutrition; social time pressure; daily behavior; daily schedules

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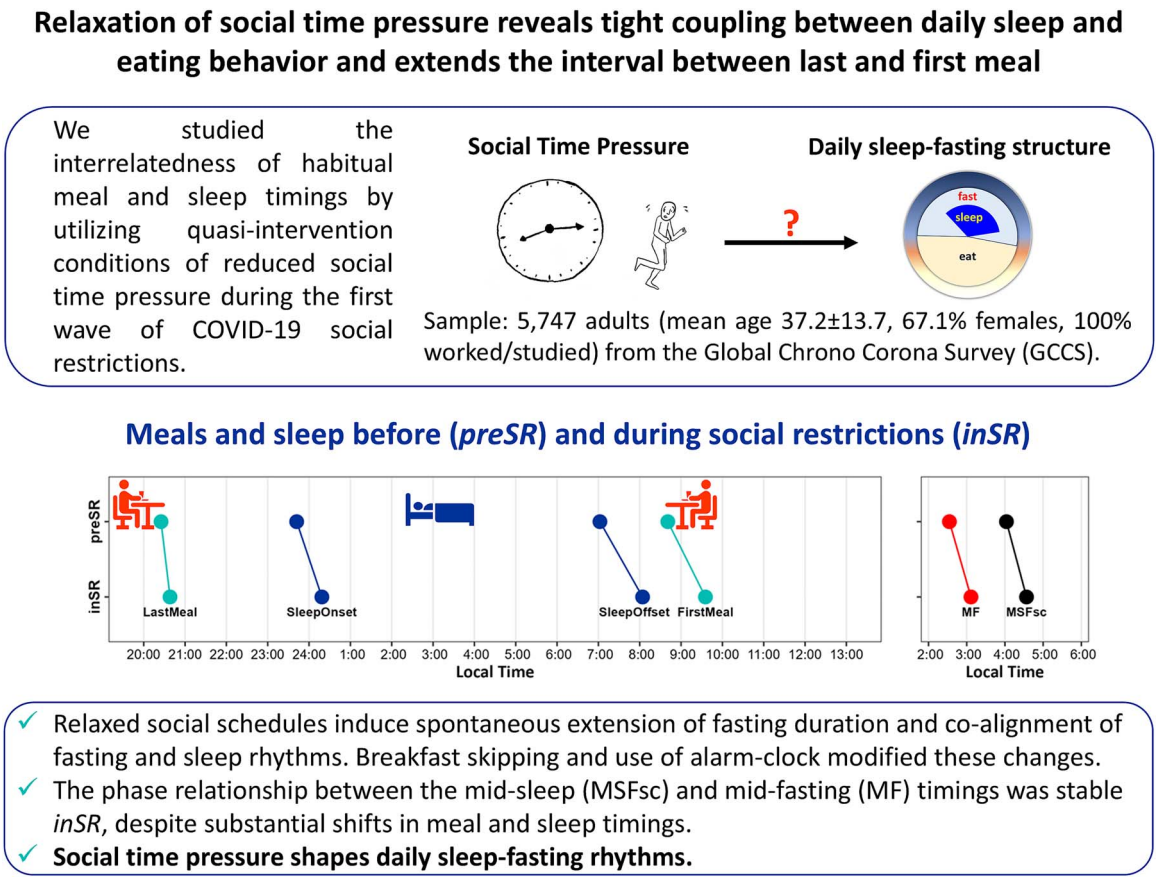
Graphical Abstract



Statement of Significance

The current study leverages the unique quasi-experimental context of COVID-19 social restrictions (SRs) to reveal a previously unexplored link between social time pressure (STP), daily fasting and sleep in a large, global adult sample from the Global Chrono Corona Survey. We demonstrate that relaxed social schedules induce spontaneous extension of fasting duration and co-alignment of fasting and sleep rhythms. During SRs, the sleep-fasting phase relationship was stable, despite substantial shifts in meal and sleep timings. These findings unveil the role of STP in shaping daily rhythms, with broad implications for metabolic and sleep health. The daily sleep-fasting structure can serve as a novel marker for future research and interventions aimed at optimizing circadian health outcomes in modern societies.

Introduction

Being diurnal by nature, humans have evolved to receive light and food coincidentally. We perform most vigorous activities, including eating, during the natural light time, while rest and fasting happen mainly during the night. Fundamental to the circadian (circa = about; dies = day; ~24 h) rhythms are the abilities to acquire food when it is available and to store resources during the daily fasting period, without compromising health and vitality [1]. The fasting period also serves as a time for rest and repair, such that the body is ready to harvest energy when food becomes available. However, modern humans extend the wakefulness and food consumption window far into the night by self-selecting their light–dark cycles with the ubiquitous use of electrical lighting. This capability to alter the timing of wakefulness and food intake often leads to misalignment between behavioral sleep/wake and fasting/eating cycles, as well as between behavior and physiology due to uncoupling of the central circadian clock in the suprachiasmatic nucleus (SCN) of the anterior hypothalamus from the peripheral clocks [1].

Circadian clock regulation and entrainment

Circadian rhythms in almost all body functions, from sleep patterns to hunger, are orchestrated by the central clock (the SCN) in synchrony with the environmental light/dark cycle [2–4]. Human physiology is also affected significantly by peripheral circadian clocks, such as the metabolic tissue clock in the liver. For these peripheral clocks, the timing of food intake, hence also the fasting time, is the most potent external synchronizer [5, 6]. Metabolic hormones, circulating nutrients, and visceral neural inputs transmit rhythmic cues that synchronize the brain and peripheral organs to the feeding time [7].

The daily process of bodily clock tuning, termed entrainment, results in an individual phase relationship between the circadian clock and the light/dark cycle of the individual [8]. The

entrainment is reflected in almost all aspects of both physiology (e.g., hormone secretion or body temperature) and behavior (e.g., fasting/eating and sleep/wake cycles) [9]. Importantly, lipid rhythms in humans appear to be preferentially sensitive to changes in meal timing, whereas centrally controlled rhythms such as melatonin, cortisol, and body temperature are more sensitive to photic time cues [10, 11]. In humans, entrainment of the body clocks is also tightly linked to the social clock, which assigns local time to events such as work, meals, or leisure [2–4].

Health implications of sleep and fasting duration

Sleep duration (SD) is a well-established determinant of health, with both short and long sleep being associated with negative health outcomes [12, 13]. Similarly, the importance of daily fasting duration (FD) is well recognized. A short (<12 h) FD is associated with elevated risk for development of metabolic diseases, contributing to reduced quality of life, poorer health and a shorter life expectancy [14, 15]. Conversely, recent evidence indicates that a very prolonged daily fasting window may be associated with elevated mortality risk [16, 17]. A recent systematic review and its meta-analysis also stresses the importance of early initiation of the long daily fasting window, placing "dinner skippers" at an advantage over "breakfast skippers," stressing that timing and not only the length of the fasting window is a significant factor for weight loss [18]. Mounting evidence indicates that mistimed eating is associated with various health risks [19–21] and may facilitate excessive caloric intake [1]. Nighttime food intake has been shown to be associated with reduced amplitude of physiological and clock gene rhythms [22, 23] and with adverse metabolic and cardiovascular consequences [24, 25]. Even short-term food intake during the resting phase induces metabolic disturbances and obesity in both animals and humans [26–29], while timed meals prevent circadian desynchronization and restrict metabolic risks [7].

Circadian behaviors assessment

Epidemiologically, the body clock has been studied largely through questionnaires [30–32], with the more recent ultra-short Munich ChronoType Questionnaire (μMCTQ) [30] addressing habitual sleep schedules separately on workdays and free days. This approach evolved due to the robust effects of social time pressure (STP) on sleep habits in modern societies [33]. High STP on workdays is ubiquitous and associated with using an alarm clock on workdays and daily commuting to the workplace/college [34, 35]. For many people, sleep timing on free days significantly differs from workdays, a discrepancy termed "social jetlag" (SJL) [4, 20]. Larger SJL has been linked to metabolic risks [26, 36, 37], with every hour of SJL increasing the chance of being overweight by 30% [20]. Individual chronotype and SJL may play an important role in fasting/eating rhythm [26], but there is a paucity of direct evidence for their interaction in real-life settings.

Study rationale and significance

Quantifying the interrelatedness of human daily fasting and sleep behaviors, and their relationship with STP in natural settings poses significant challenges due to the scarcity of suitable ecological conditions allowing long-term modifications in STP. The social restrictions (SRs) during COVID-19 lockdowns provided a unique quasi-experimental opportunity to directly examine the impact of prolonged changes in the social clock on fasting and sleep timing, as well as their coupling. Previous studies have shown that SRs were associated with reduced STP and triggered robust changes in sleep/wake behaviors and wellbeing in the general public worldwide [35, 38, 39]. However, despite its high relevance to metabolic health research, the impact of SRs on meal timing and the stability of the fasting-sleep phase relationship remains surprisingly under-investigated in large-scale studies. Most research has maintained a primary focus on the quantity and composition of consumed food and liquids [40], leaving a critical gap in our understanding of how social constraints affect the temporal coordination of sleep and fasting behaviors. This study addresses this knowledge gap by investigating how reduced STP during COVID-19 lockdowns affected the coupling between sleep and fasting behaviors, providing crucial insights into the malleability of these interrelated biological rhythms and their potential for optimization in promoting metabolic health.

Here, we focused on the interrelatedness of the changes in habitual timings of meals (first and last) and sleep (onset and offset) during the first wave of SRs imposed due to the outbreak of the COVID-19 pandemic (April–May 2020). Of the 11 431 adults from 40 countries who opened the link to the digital Global Chrono Corona Survey (GCCS), we excluded those who did not work or study at both before and during SRs (*preSR* and *inSR*, respectively), shift-workers, those diagnosed with COVID-19 or who had missing or nonsense data, leaving 5747 participants in the analytical sample (mean age 37.17 ± 13.66, 67.1% females) (The research ethics committee approval AU-HEA-MK-20200629). Characteristics of the sample are presented in Supplementary Information 1. We assumed that the lockdowns shielded the circadian clock from the habitual STP because many people had switched to a more flexible work-from-home routine and maintained social distancing for an extended duration spanning many weeks. We focused on the analysis of the within-subject changes in habitual daily FD and timing during SRs as compared to before SRs (*inSR* and *preSR*, respectively) and the investigation of the associations between fasting/eating and sleep/wake behavior. FD was defined as the self-reported period of abstinence from food intake, including snacks, between participants' last and first meals. It is important to acknowledge that we operationalize "fasting" as a behavioral rather than a caloric construct, recognizing that self-reported data may not perfectly capture the physiological state of complete caloric abstinence. We tested three primary hypotheses: (1) relaxed STP *inSR* is associated with a prolonged habitual FD and a delayed fasting window, (2) changes in fasting/eating behavior are associated with changes in SD and timing, and (3) greater changes are found in later chronotypes.

Materials and Methods

The study was approved by the Ariel University Human Research Ethics Committee (AU-HEA-MK-20200629). All respondents provided electronic consent. Participation in the survey was anonymous. The data were collected via SoGoSurvey platform (Herndon, Virginia, US), which enables multilingual surveys. The GCCS was afforded in 10 languages and advertised worldwide thanks to the international collaboration between researchers from different countries (see Acknowledgments). Participants were recruited via digital advertisements at universities, social networks, and email-based approaches (convenience sample). The survey was presented as a study investigating daily habits during the COVID-19 pandemic.

The GCCS queried habitual meal and sleep timing before and during the SRs (preSocialRestriction, *preSR*, and inSocialRestriction, *inSR*, respectively) during the first wave of the COVID-19 pandemic. The survey included 11 431 adults from 40 countries, who responded between 4.4.2020 and 16.05.2020. Top response

rates came from Portugal, Italy, United States, United Kingdom, Germany, Israel, India, Russia, Japan, and Brazil. The sample presented in this manuscript included 5747 respondents (67% females, mean age 37 ± 14 years), all of whom worked or studied at both time points (82% worked from home in the *inSR*). Exclusions were applied to responders who reported COVID-19 diagnosis (present or past), shift/night workers, unemployed, responders with extreme SDs (<3 h and >14 h), because such values are likely to be indicative of a typing error or a sleep pathology, e.g., insomnia or a central disorder of hypersomnolence [41, 42], and those with missing or invalid data. Additionally, to correct for the overrepresentation of young (ages 18–22 years old) participants from Russia relative to two other leading countries in this age group (India and Japan), we excluded 656 participants from Russia (5.7%) using random procedures in R. The participants were, on average, 32.6 ± 9.0 days under SRs, suggesting full adaptation to new social schedules. Sociodemographic data are presented in Supplementary Information (Supplementary Information 1).

The GCCS respondents were asked to provide basic demographic information and to answer questions about sleep and meal timings *preSR* (prior to Corona outbreak) and *inSR* ("currently," during Corona outbreak). The clock time (hh:mm, 24 h format) of the habitual first and last meal, including snacks, was reported without specification of the weekday. For example, the question regarding the first meal *preSR* was: "Prior to Corona outbreak, I used to eat for the first time during the day (including snacks) at ..:.. (hh:mm)." The sleep-related questions were modified from the ultra-short version of the Munich ChronoType Questionnaire (μMCTQ) [30]. Participants reported the habitual sleep onset and offset clock times and the use of an alarm clock, separately on work and free days. The reported fasting/eating behavior parameters were assumed to mainly reflect habits during workdays based on the analysis of the differences between the reported first meal and sleep offset times that clearly demonstrated that habitual meal timing reflected eating habits during workdays (see Supplementary Information 3). Therefore, fasting data analysis was performed in reference to sleep parameters (e.g., SD and mid-sleep time) on workdays, and in reference to sleep/wake-assessed chronotype (represented by the mid-sleep time on free days corrected for sleep debt on workdays, also known as MSF_{sc}) [4].

Figure 1 graphically presents the main outcome variables of the study that were calculated from the reported first/last daily meals and sleep timings. The following parameters were calculated for each individual:

1. **FD—fasting duration** (hours)—the difference between the last (evening) and the first (morning) meal. Note that F
2. **MF—mid-fasting point** (local time)—the mid-fasting time of the fasting period.
3. **preS-FD—presleep fasting duration** (hours)—last meal to sleep onset on workdays interval
4. **postS-FD—postsleep fasting duration** (hours)—sleep offset on workdays to first meal interval
5. **MSF_{sc}—sleep/wake assessed chronotype** (local time)—the mid-sleep time on free days corrected for sleep deficit on workdays.
6. **SD—**nocturnal **sleep duration** (hours) on workdays—the difference between the sleep onset and offset on workdays.
7. **SJL—social jetlag** (hours)—the difference between mid-sleep times on workdays (MSW) and free days (MSF).

We used nonparametric data analyses since not all the daily behavior variables showed normal distribution and/or were homoscedastic. Wilcoxon Matched-Pairs tests were used to assess the within-subject changes in daily behavior. Spearman's rank correlation analysis was performed to assess associations between daily behavior measures. The *excessmass* function in R was used to calculate the Ameijeiras-Alonso et al. excess mass test, for identifying the number of modes specified in the distribution of the sample [43, 44]. Data analyses of eating parameters (FD, MF) were performed in reference to sleep parameters on workdays (SD, MS), based on the trivial definition that the sleep offset time cannot be later than the first meal. Statistical analyses were performed using SPSS version 26 (SPSS Inc., Chicago, IL, USA) which was used for descriptive statistics and preliminary analytics and R, which was used for final analysis of the data. The level of significance was set at $p < .05$.

Results

Prior to describing the changes in fasting and their sleep correlates, we present the evidence showing that in the majority of the sample, the STP during SRs was profoundly relaxed. Notably, all individuals in the sample worked or studied both *preSR* and *inSR* and had been on average 32.57 ± 8.98 days under SRs, presumably allowing full adaptation to new, relaxed social schedules. None of the participants reported COVID-19 illness (furthermore, survey participation preceded the availability of vaccinations against COVID-19). *PreSR*, 84.2% of the responders reported they used the alarm clock on workdays and only 12.1% worked or studied from home. *InSR*, 56.6% of the same sample used the alarm clock on workdays and 82.0% worked/studied from home (alarm clock use change: $\chi^2 = 1422.36$, $p < .001$; work from home change: $\chi^2 = 118.62$, $p < .001$).

PreSR → inSR changes in eating and sleep behavior

Habitual FD increased *inSR* on average by 0:42 ± 1:50 min (FD change from 12:16 ± 2:09 to 12.57 ± 2:04). Detailed statistics of the changes in the dependent variables are reported in Table 1. The distributions of FD in the sample and the individual changes *preSR* and *inSR* are shown in Figure 2, A1. FD increased in the majority, 59.0%, of the sample, 17.3% did not change and only 23.7% shortened FD *inSR*. In the scatter plots presenting individual data points, the regression line for FD produced an intersect with the 1:1 diagonal at a crossing point value of 14.1 h (Figure 2, B1, red dot). This point indicates that people who had FD < 14.1 h *preSR* tended to prolong the FD, while participants with FD > 14.1 h tended to decrease it *inSR*. The increase in FD was concurrent with gains in habitual SD on workdays which increased *inSR* on average by 0:25 ± 1:12 (SD change from 07:20 ± 1:08 to 07:46 ± 1:15). Age inversely correlated with ΔFD ($\rho_S = -0.18$, $p < .001$), the magnitude of the respective changes decreased consistently with age, but nevertheless, all age groups showed significant ΔFD (see Supplementary Information 2). No significant.

Changes in FD and SD correlated significantly ($\rho_S = 0.26$, $p < .001$), but the extension of the total FD was larger than the increase in SD *inSR*, on average, by 0:16 ± 1:55 (FD-SD). This is explained by the fact that the presleep FD (preS-FD, from the Last Meal to Sleep Onset) also increased, on average, by 0:24 ± 1:22 (preS-FD, 3:17 ± 1:24 to 3:40 ± 1:40) while the postsleep FD (postS-FD, from the Sleep Offset to the First Meal) slightly decreased, on average, by 0:07 ± 1:25 (postS-FD, 1:39 ± 1:44 to 1:31 ± 1:30) (Figure 2, C1). Note that this pattern was universal - the presleep FD increased in all 8 top contributing countries, while the postsleep FD showed mixed tendencies, with many countries showing decreases in post-S-FD, *inSR* (see Supplementary Information 2).

Changes in FD were accompanied by a robust delay in the mid-fasting time (MF), on average, by 0:34 ± 1:14 (MF change:

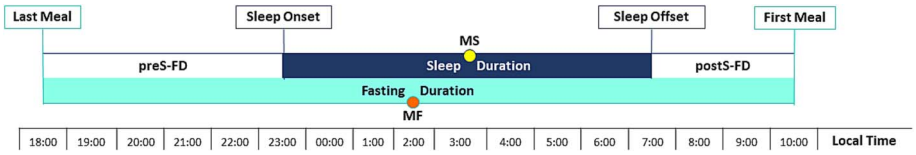


Figure 1. A hypothetical graphical display of the fasting and sleep outcome measures used in this report. All parameters were calculated separately per participant for *preSR* and *inSR* time-points. Fasting duration and midfast-time (MF, orange dot) are calculated from the answers to questions about habitual timing of last and first meals of the day. Three intervals sum up to FD (turquoise): The last meal to sleep onset (preS-FD, presleep fasting duration), the SD (dark blue), and the sleep offset to the first meal (postS-FD, postsleep fasting duration). SD and midsleep-time (MS, yellow dot) are calculated from the answers to questions about habitual timing of sleep onset (falling asleep) and sleep onset (wake-up) on workdays. The x-axis represents local time in hh:mm format.

Table 1. Meal and sleep parameters in the general sample and the within-subject *preSR*/*inSR* comparisons using wilcoxon matched-pairs two-tailed tests for each of the measures

Parameter	*preSR* *Mean ± SD* *Median [IQR]*	*inSR* *Mean* *Median [IQR]*	Z	Δ
FD	12:16 ± 2:09 12:00 [2:30]	12:57 ± 2:04 12:45 [2:30]	−29.70**	0:42 ± 1:50
SD	7:20 ± 1:08 7:30 [1:15]	7:46 ± 1:15 8:00 [1:30]	−26.90**	0:25 ± 1:12
MF	2:33 ± 1:19 2:22 [1:38]	3:07 ± 1:35 3:00 [2:00]	−35.40**	0:34 ± 1:14
MS	3:22 ± 1:02 3:15 [1:38]	4:11 ± 1:35 4:00 [1:53]	−47.70**	0:49 ± 1:11
LM	20:25 ± 1:26 20:45 [1:30]	20:38 ± 1:44 20:30 [2:00]	−12.3**	0:13 ± 1:18
FM	8:41 ± 1:56 8:00 [2:15]	9:35 ± 2:03 9:00 [3:00]	−39.6**	0:55 ± 1:44
Sleep Onset	23:42 ± 1:13 23:30 [1:30]	00:19 ± 1:41 00:00 [2:15]	−34.8**	0:37 ± 1:15
Sleep Offset	7:02 ± 1:08 7:00 [1:15]	8:04 ± 1:43 8:00 [2:00]	−49.2**	1:02 ± 1:24
preS-FD	3:17 ± 1:24 3:15 [1:45]	3:40 ± 1:40 3:30 [2:15]	−21.9**	0:24 ± 1:22
postS-FD	1:39 ± 1:44 1:00 [1:45]	1:31 ± 1:30 1:00 [2:15]	3.9**	−0:07 ± 1:25
MSF_{sc}	4:02 ± 1:20 3:58 [1:43]	4:34 ± 1:41 4:25 [2:03]	−36.5**	0:31 ± 1:07
SJL	1:06 ± 0:54 1:00 [1:07]	0:37 ± 0:46 0:30 [1:00]	38.7**	−0:29 ± 0:53

**p-value <.001. Mean ± SD, median [IQR], z-scores, and the absolute differences (Δ) between the parameters *preSR* and *inSR*. Abbreviations: FD, fasting duration; SD, sleep duration on workdays; MF, mid-fasting time; MS, mid-sleep time on workdays; LM, last meal; FM, first meal; Sleep Onset, on workdays; Sleep Offset, on workdays; preS-FD, presleep fasting duration; postS-FD, postsleep fasting duration; MSF_{sc}, sleep/wake-assessed chronotype, mid-sleep on free days corrected for sleep debt; SJL, social jetlag.

from 02:33 ± 1:19 to 03:07 ± 1:35, local time) (Figure 2, C2, detailed stats, Table 1). MF was delayed in 62.6% of the sample, 15.7% did not change and only 21.7% advanced their fasting *inSR*. Concurrently, the mid-sleep time on workdays (MS) *inSR* was delayed, on average, by 0:49± 1:11 (MS change from 03:22 ± 1:02 to 04:11 ± 1:35, local time). Changes in MF and MS correlated significantly ($\rho_S = 0.59$, $p < .001$), but MF changed less than MS (ΔMF vs. ΔMS), on average, by 0:15 ± 60:01 ($Z = 18.80$, $p < .001$). *PreSR*, sleep/wake assessed chronotype (MSF_{sc}) and MF showed medium strength correlation, *inSR* their association became strong (partial correlation, controlling for age: $\rho_S = 0.46$, $p < .001$; $\rho_S = 0.71$, $p < .001$, *preSR* and *inSR* respectively). FD and MSF_{sc} showed only negligible (though significant) correlation *preSR*, however, *inSR* their association became stronger, with later chronotypes tending to exhibit longer FD (partial correlation, controlling for age: $\rho_S = 0.05$, $p < .001$; $\rho_S = 0.16$, $p < .001$, *preSR* and *inSR*, respectively).

Drivers of the change in habitual FD

Next, we analyzed how the changes in fasting and sleep timings contributed to the observed changes in FD (Table 1). Both the last and the first meals of the day were significantly delayed *inSR* (last meal from 20:25 ± 1:26 to 20:38 ± 1:44 and the first meal from 8:41 ± 1:56 to 9:35 ± 2:03, local time) (Figure 2, A3, A4, and C1). The delay of the last meal was on average four times smaller than the delay of the first meal (0:13 ± 1:18, 0:55 ± 1:44, respective changes). The sleep onset and offset times on workdays were also delayed and presented an asymmetric pattern of changes similar to that of meal timings: while the sleep onset time became later on average by 0:37 ± 1:15 (from 23:42 ± 1:13 to 00:19 ± 1:40, local time), the sleep offset time was delayed on average by 1:02 ± 1:24 (from 7:02 ± 1:08 to 8:04 ± 1:43). In the scatter plots presenting individual data points (Figure 2, B4) the regression line for the first meal produced an intersect with the 1:1 diagonal at a crossing

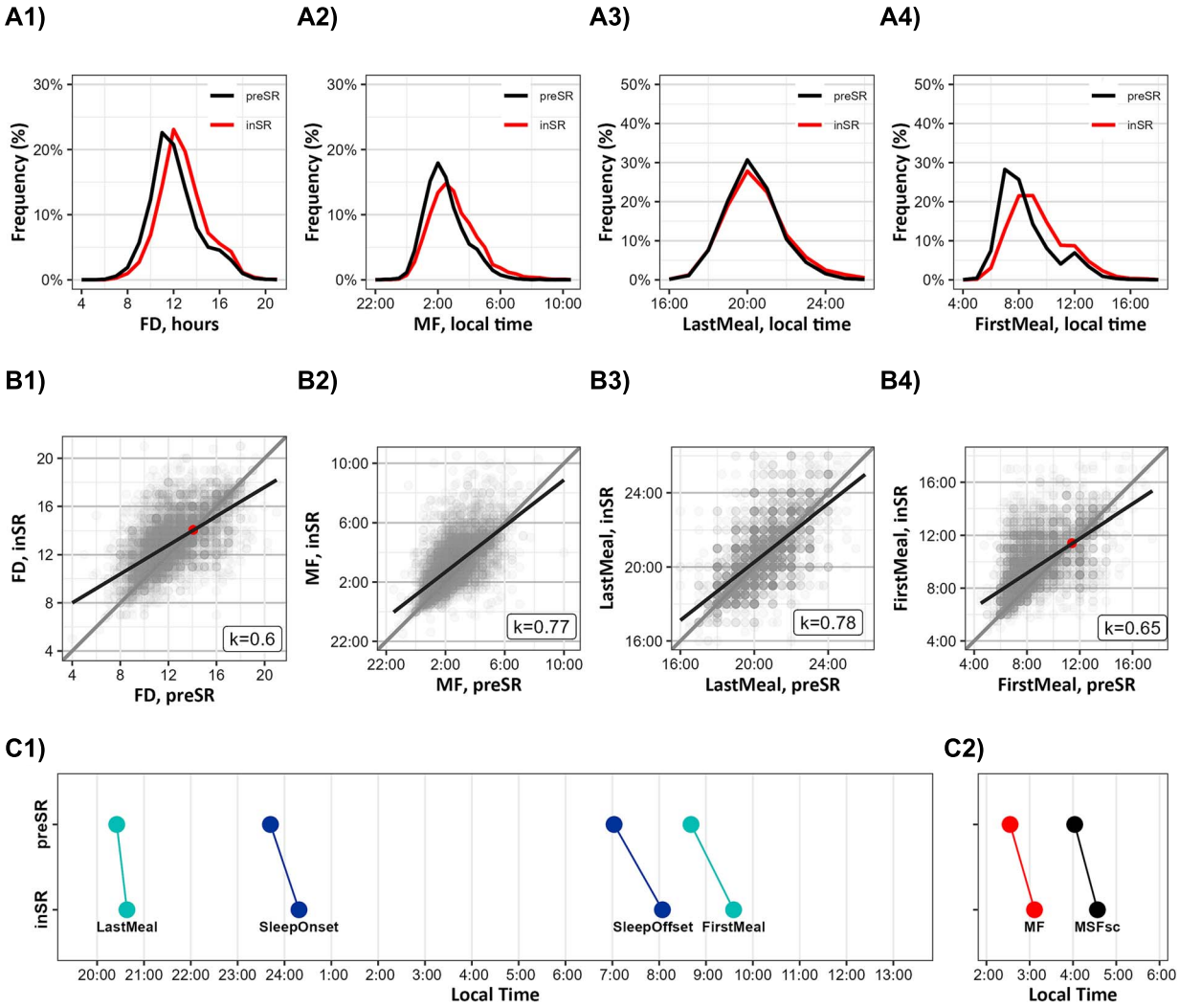


Figure 2. SR-induced changes in daily behaviors from *preSR* to *inSR*. (A1–A4) Distributions of FD, MF, last meal, and first meal *preSR* (black line) and *inSR* (red line), percent from group total. (B1–B4) Scatterplots of individual shifts in FD, MF, last meal, and first meal *preSR* (x-axis) vs. *inSR* (y-axis). Each dot represents an individual participant; overlapping dots are coded by color intensity. The diagonal line designates no restriction-induced change in the displayed parameter; points above the line indicate an increase in the parameter. Regression lines (black) illustrate the relationship between the parameter values *preSR* (x-axis) and *inSR* (y-axis), k—slope coefficient of the regression line. The red dots designate the intersection point between the diagonal and the regression line in parameters. (C1) The summary of changes in meal and sleep timings (last and first meals—turquoise; sleep onset and sleep offset times on workdays—dark blue). (C2) changes in sleep/wake assessed chronotype (MSF_{sc}—red) and fasting/eating assessed chronotype (MF—gray). The x-axis represents local time in hh:mm format.

point value 11:15, indicating that participants that had their first meal before 11:15, tended to delay it *inSR*.

Sleep/wake-assessed chronotype, the MSF_{sc}, showed *inSR* changes that were very similar to the changes in MF. On average, the MSF_{sc} was delayed by 0:31 ± 1:07 (change from 04:02 ± 1:20 to 04:34 ± 1:41, local time), with 66.2% of the sample showing a delay, 9.7% no change and 22.6% an advance of their sleep interval. Altogether, the shifts in the MF relative to the MSF_{sc} were practically identical (0:02 ± 1:08 min difference), with the MF being stably ~1.5 h ahead of sleep/wake-assessed chronotype both *preSR* and *inSR* (Figure 2, C2). The SJL decreased on average by 00:29 ± 00:53, indicating a robust alignment of sleep times between work- and work-free days *inSR*. Larger delays in the MSF_{sc} and decreases in SJL were associated with younger age ($\rho_S = 0.206$, $p < .001$, $\rho_S = 0.273$, $p < .001$, ΔMSF_{sc} and ΔSJL, respectively).

Differences between breakfast skippers and breakfast eaters. Notably, the Ameijeiras-Alonso excess mass test suggested that the distribution of the first meal timing in the sample was significantly bimodal *preSR* (excess mass = 0.043, $p < .001$) (evident from the visual inspection of Figure 2, A4), suggesting that there are two subgroups with distinct behavioral patterns related to the postsleep FD. Accordingly, we split the sample into "Breakfast Skippers"—participants who reported that they had their first meal at 11:00 or later ($n = 895$) and "Breakfast Eaters"—those had their first meal before 11:00 ($n = 4852$). The two groups were slightly, but significantly, dissimilar in age and sex composition (Breakfast Skippers: 35.8 ± 13.2 years, 60.4% females, Breakfast Eaters: 37.4 ± 13.7 years, 68.3% females). Detailed statistics of all dependent variables by group are reported in Supplementary Information 1, subgroups description.

The relaxation of STP induced opposite changes in fasting/eating behavior of the two subgroups: the Breakfast Skippers shortened their FD by 0:42 ± 2:05 and advanced the MF by 0:07 ± 1:26, while the Breakfast Eaters prolonged their FD by 0:57 ± 1:40 and delayed the MF by 0:41 ± 1:09 (Figure 3, A1 and A2, respectively). Mann–Whitney tests (with Breakfast Eaters/ Breakfast Skippers groups as between-subject factor) showed significant differences

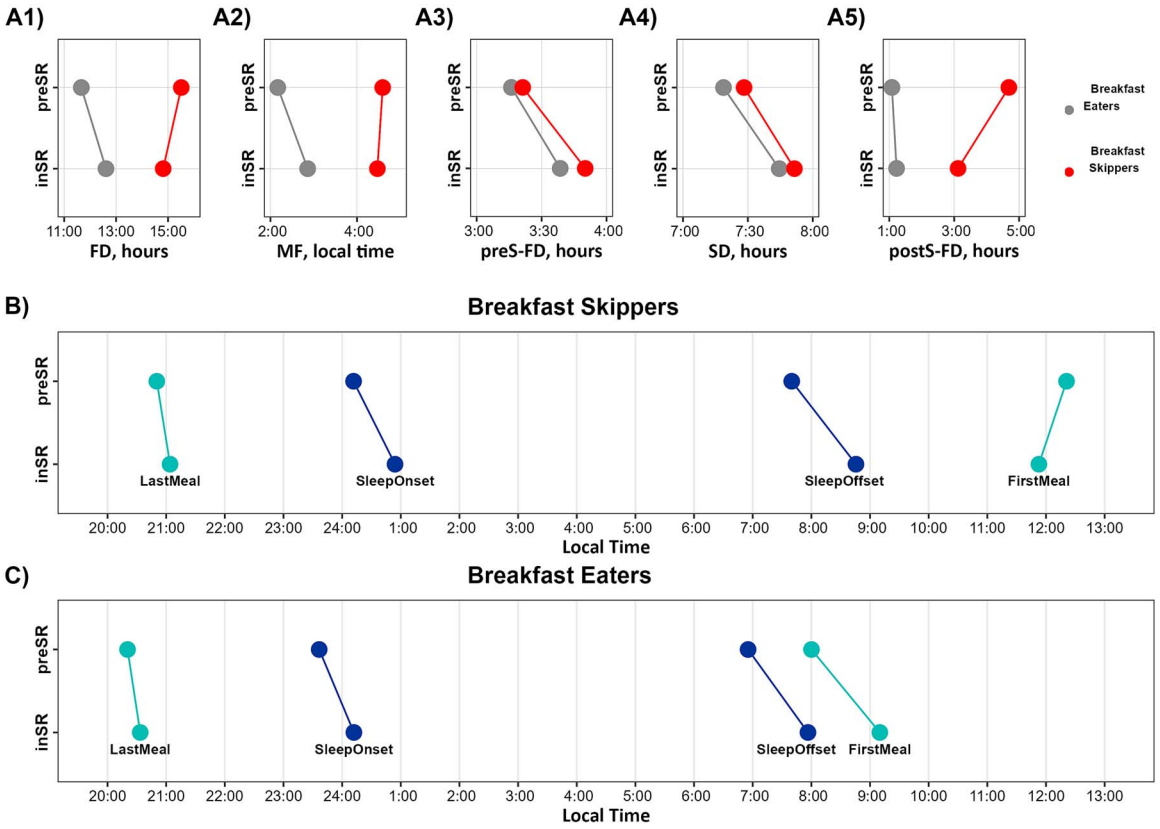


Figure 3. Changes in daily behaviors by group: Breakfast eaters vs. breakfast skippers. (A1–A5) Mean values of individual FD (hours), MF (local time), and the components constituting FD in breakfast eaters (gray markers) and breakfast skippers (red markers) groups: preS-FD—presleep fasting duration, SD—sleep duration on workdays, postS-FD—postsleep fasting duration, *preSR* and *inSR*. Note that the main difference between groups is in the postsleep FD changes. (B and C) The summary of changes in times of meals and sleep from *preSR* to *inSR*, by group: panel (B) breakfast skippers, panel (C) breakfast eaters. Last and first meals—turquoise; sleep onset and sleep offset times on workdays—dark blue. The x-axis represents local time in hh:mm format.

between groups with respect to gains in FD and delay of the MF (ΔFD, $Z = -22.43$, $p < .001$; ΔMF: $Z = -18.04$, $p < .001$). Nevertheless, in spite of the fact that Breakfast Skippers dramatically shortened their FD, their FD *inSR* was significantly longer than the FD of the Breakfast Eaters ($Z = -26.22$, $p < .001$), see details in Table 2.

The analysis of the underlying changes in the components constituting FD (Figure 3, A3–A5) showed that while both groups prolonged the presleep FD, Breakfast Skippers had on average somewhat larger gains in the presleep FD (ΔpreS-FD, 0:29 ± 1:34 vs. 0:23 ± 1:20, $Z = -2.17$, $p = .03$). No differences were obtained between groups in SD gains (ΔSD, $Z = -0.61$, $p = .54$). The main contributor to the differences in FD gains between Breakfast Skippers and Breakfast Eaters was the robust, above hour and a half (1:34 ± 2:01 h), shortening of the postsleep FD in Breakfast Skippers (ΔpostS-FD, $Z = 19.30$, $p < .001$), as opposed to 0:09 ± 1:04 extension of the duration in Breakfast Eaters (ΔpostS-FD, $Z = -8.49$, $p < .001$).

Breakfast Skippers were on average much later chronotypes (*preSR* MSF_{sc}, 4:42 ± 1:41, 3:55 ± 1:13, Breakfast Skippers and Breakfast Eaters, respectively; Mann–Whitney U-test, $Z = 13.70$, $p < .001$). However, in both groups, the sleep/wake assessed chronotype was similarly delayed by ~30 min *inSR* and therefore kept the difference in chronotype *inSR*. Both groups had almost similar SJL *preSR* (1:12 ± 0:57, 1:05 ± 0:53) and showed similar reductions of ~40 min in the SJL *inSR*.

Nonuse of an alarm clock on workdays promotes larger gains in FD inSR. Compliance with social times is ubiquitously achieved by using an alarm clock and allocating time to commute to the place of work or study. To assess the impact of the changes in alarm-clock use and work from home on changes in fasting/eating behavior *inSR*, we selected a subgroup of participants who used an alarm clock on workdays *preSR*, and worked/studied from home *inSR*. This group ($N = 3.955$) was then subdivided into those who stopped using an alarm clock *inSR* (Alarm/NoAlarm; $N = 1469$) and those who continued to use an alarm clock inSR (Alarm/Alarm; $N = 2,486$). The two groups were similar in age and sex composition (35.26 ± .13.25, 68.9% females, 35.30 ± 12.22, 68.6% females, Alarm/NoAlarm and Alarm/Alarm groups, respectively).

Both groups presented robust changes in fasting/eating behavior, see details in Table 3. Nevertheless, the changes in the Alarm/NoAlarm group were on a larger magnitude compared to the Alarm/Alarm group (Figure 4, A1 and A2), as reflected in larger FD gains and larger MF point delay (ΔFD, 00:24 ± 00:04, $Z = -6.77$, $p < .001$; ΔMF, 00:19 ± 00:02, $Z = -8.08$, $p < .001$). Both groups prolonged all three component durations, with significantly larger gains in the Alarm/NoAlarm for the presleep FD (ΔpreS-FD, 00:14 ± 00:03, $Z = -4.78$, $p < .001$) and SD (ΔSD, 00:19 ± 00:03, $Z = -7.73$, $p < .001$) but not in the postsleep FD (ΔpostS-FD, $p = .075$) (Figure 4, A3, A4, and A5, respectively). Altogether, larger spontaneous gains in habitual FD and larger delays of the mid-fasting point were observed in participants who stopped using an alarm clock on workdays *inSR* (Figure 4, panels B and C).

Participants of the Alarm/NoAlarm group were slightly earlier chronotypes and presented somewhat smaller SJL preSR (*preSR* MSF_{sc}, 4:08 ± 1:20, 4:14 ± 1:15; *preSR* SJL, 1:10 ± 0:52, 1:16 ± 0:51, Alarm/NoAlarm and Alarm/Alarm, respectively; Mann–Whitney U-test, $Z = -2.67$, $p = .008$; $Z = -3.74$, $p < .001$). The changes in

Table 2. Changes in meals and sleep by group: breakfast skippers and breakfast eaters, from *preSR* to *inSR*

Parameter	Group	*preSR*	*inSR*	*Z*	Delta
FD	Skippers	15:31 ± 1:48	14:49 ± 2:15	9.25**	−0:42 ± 2:05
	Eaters	11:40 ± 1:36	12:37 ± 1:51	−36.90**	0:57 ± 1:40
SD	Skippers	7:28 ± 1:15	7:52 ± 1:19	−9.31**	0:23 ± 1:22
	Eaters	7:19 ± 1:07	7:44 ± 1:14	−25.30**	0:26 ± 1:10
MF	Skippers	4:36 ± 1:03	4:28 ± 1:42	3.10*	−0:07 ± 1:26
	Eaters	2:10 ± 0:58	2:52 ± 1:26	−40.20**	0:41 ± 1:09
LM	Skippers	20:50 ± 1:37	21:04 ± 2:02	−4.16**	0:14 ± 1:37
	Eaters	20:20 ± 1:23	20:33 ± 1:39	−11.60**	0:13 ± 1:15
FM	Skippers	12:21 ± 1:06	11:53 ± 2:03	6.91**	−0:28 ± 1:55
	Eaters	8:00 ± 1:07	9:10 ± 1:45	−46.30**	1:10 ± 1:34
Sleep Onset	Skippers	0:12 ± 1:27	0:54 ± 2:02	−13.70**	0:42 ± 1:27
	Eaters	23:37 ± 1:08	0:12 ± 1:35	−32.00**	0:35 ± 1:13
Sleep Offset	Skippers	7:40 ± 1:37	8:46 ± 2:06	−18.00**	1:06 ± 1:38
	Eaters	6:55 ± 0:59	7:57 ± 1:36	−46.00**	1:01 ± 1:22
preS-FD	Skippers	3:21 ± 1:27	3:50 ± 1:46	−9.49**	0:29 ± 1:34
	Eaters	3:16 ± 1:23	3:39 ± 1:38	−19.80**	0:23 ± 1:20
postS-FD	Skippers	4:41 ± 1:48	3:07 ± 2:06	19.30**	−1:34 ± 2:01
	Eaters	1:05 ± 0:58	1:14 ± 1:08	−8.49**	0:09 ± 1:04
MSFsc	Skippers	4:42 ± 1:41	5:15 ± 2:01	−13.20**	0:33 ± 1:17
	Eaters	3:55 ± 1:13	4:26 ± 1:35	−34.10**	0:31 ± 1:05
SJL	Skippers	1:12 ± 0:57	0:38 ± 0:50	15.90**	−0:33 ± 0:59
	Eaters	1:05 ± 0:53	0:37 ± 0:46	35.20**	−0:28 ± 0:52

*.05 < *p*-value <.001. **p-value <.001. Wilcoxon Matched-Pairs two-tailed comparisons z-scores and *p*-values. Mean ± SD, z-scores, *p*-values, and the absolute differences between the parameters *preSR* and *inSR*. Abbreviations: FD, fasting duration; SD, sleep duration on workdays; MF, mid-fasting time; LM, last meal; FM, first meal; Sleep Onset, on workdays; Sleep Offset, on workdays; preS-FD, presleep fasting duration; postS-FD, postsleep fasting duration; MSF_{sc}, sleep/wake-assessed chronotype, mid-sleep on free days corrected for sleep debt; SJL, social jetlag.

Table 3. Changes in meals and sleep by group: alarm/noalarm and alarm/alarm, from *preSR* to *inSR*

Parameter	Group	*preSR*	*inSR*	*Z*	Delta
FD	Alarm/Alarm	12:13 ± 2:07	12:52 ± 1:59	−19.20**	0:39 ± 1:49
	Alarm/NoAlarm	12:22 ± 2:08	13:25 ± 2:02	−19.30**	1:04 ± 1:60
SD	Alarm/Alarm	7:17 ± 1:03	7:42 ± 1:08	−18.20**	0:25 ± 1:06
	Alarm/NoAlarm	7:26 ± 1:10	8:09 ± 1:14	−19.10**	0:43 ± 1:22
MF	Alarm/Alarm	2:33 ± 1:17	3:05 ± 1:30	−23.10**	0:32 ± 1:12
	Alarm/NoAlarm	2:38 ± 1:19	3:30 ± 1:37	−22.50**	0:52 ± 1:23
LM	Alarm/Alarm	20:27 ± 1:24	20:39 ± 1:41	−7.71**	0:12 ± 1:20
	Alarm/NoAlarm	20:27 ± 1:26	20:47 ± 1:49	−8.84**	0:20 ± 1:25
FM	Alarm/Alarm	8:40 ± 1:53	9:32 ± 1:54	−26.40**	0:52 ± 1:39
	Alarm/NoAlarm	8:48 ± 1:56	10:12 ± 2:00	−24.00**	1:24 ± 1:57
Sleep Onset	Alarm/Alarm	23:48 ± 1:08	0:23 ± 1:32	−23.30**	0:34 ± 1:07
	Alarm/NoAlarm	23:41 ± 1:13	0:36 ± 1:49	−22.00**	0:55 ± 1:26
Sleep Offset	Alarm/Alarm	7:06 ± 1:02	8:05 ± 1:27	−34.70**	0:59 ± 1:11
	Alarm/NoAlarm	7:07 ± 1:08	8:45 ± 1:49	−29.10**	1:38 ± 1:38
preS-FD	Alarm/Alarm	3:21 ± 1:22	3:43 ± 1:36	−14.40**	0:22 ± 1:21
	Alarm/NoAlarm	3:14 ± 1:26	3:49 ± 1:47	−15.00**	0:35 ± 1:30
postS-FD	Alarm/Alarm	1:34 ± 1:43	1:27 ± 1:27	2.52*	−0:07 ± 1:26
	Alarm/NoAlarm	1:42 ± 1:43	1:27 ± 1:21	4.94**	−0:15 ± 1:30
MSFsc	Alarm/Alarm	4:14 ± 1:15	4:45 ± 1:32	−25.40**	0:31 ± 0:59
	Alarm/NoAlarm	4:08 ± 1:20	4:52 ± 1:47	−21.70**	0:43 ± 1:19
SJL	Alarm/Alarm	1:16 ± 0:51	0:50 ± 0:47	24.70**	−0:26 ± 0:50
	Alarm/NoAlarm	1:10 ± 0:52	0:19 ± 0:36	28.10**	−0:51 ± 0:56

*0.05 < *p* value <.001. **p-value <.001. Note that all participants worked/studied from home *inSR*. Wilcoxon Matched-Pairs two-tailed comparisons z-scores and *p*-values. Mean ± SD, z-scores, *p*-values, and the absolute differences between the parameters *preSR* and *inSR*. Abbreviations: FD, fasting duration; SD, sleep duration on workdays; MF, mid-fasting time; LM, last meal; FM, first meal; Sleep Onset, on workdays; Sleep Offset, on workdays, preS-FD, presleep fasting duration; postS-FD, postsleep fasting duration; MSF_{sc}, sleep/wake-assessed chronotype, mid-sleep on free days corrected for sleep debt; SJL, social jetlag.

the chronotype and SJL *inSR* were significantly different in the two groups; both groups delayed the chronotype by ∼30 min and therefore kept the difference in chronotype *inSR* (Table 3).

Discussion

The "Social Restrictions Experiment" provided by the global pandemic was a rare opportunity to obtain spontaneous temporal rearrangement of eating and sleep schedules in a real-life setting. The analytic sample consisted of 5747 adults, all working/studying, who were surveyed after spending on average over a month in altered conditions. Before SR, many responders suffered from high STP, as evident from the magnitude of the social jetlag (mean SJL *preSR*: 1:06 ± 0:54 h) and from the ubiquitous use of alarm clocks on workdays (84.2% of the responders). We show that relaxation of the STP led to robust increases in FD (on average, by 42 min)

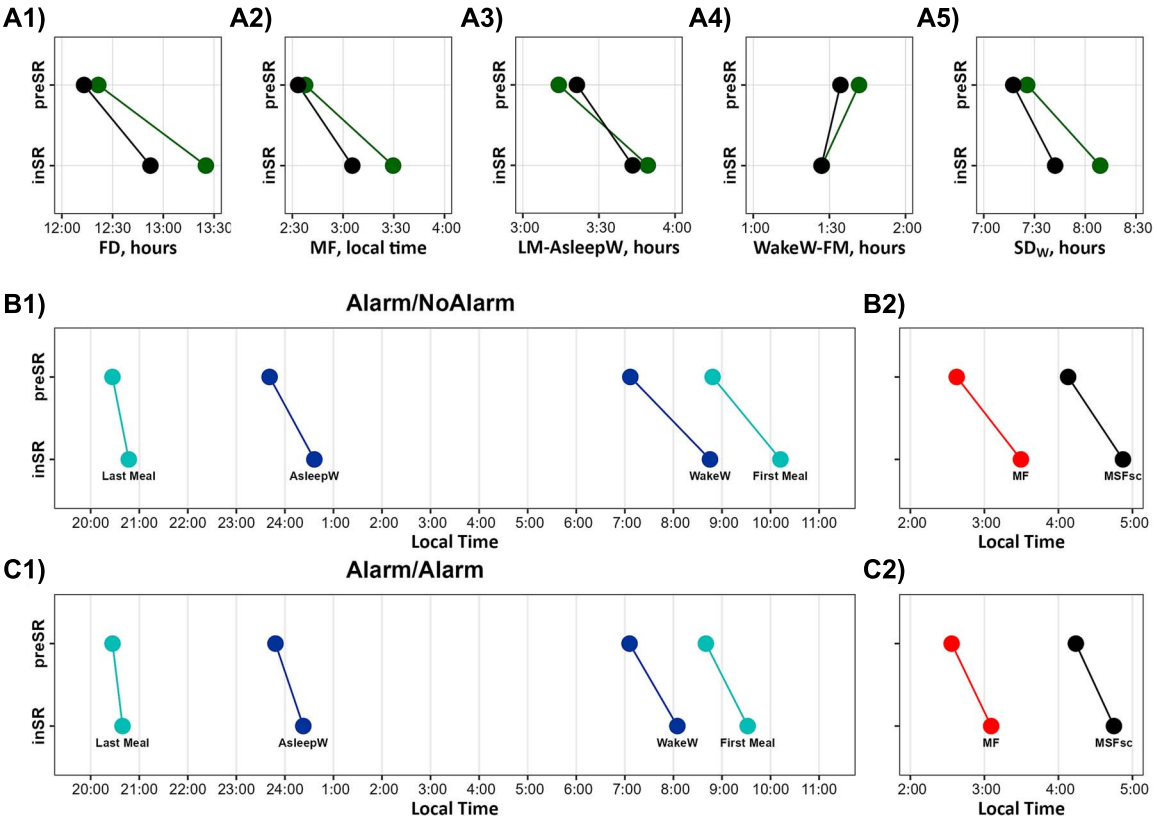


Figure 4. The contribution of alarm clock use on workdays to changes in daily behavior. Participants who worked from home *inSR* and used an alarm clock both *preSR* and *inSR* constitute the Alarm/Alarm group, and participants who worked from home *inSR*, used an alarm clock *preSR* and stopped using the alarm *inSR* constituted the Alarm/NoAlarm group. (A1–A5) Mean values of individual FD (hours), MF (local time), and durations constituting FD in Alarm/NoAlarm (green markers) and Alarm/Alarm (black markers) groups preS-FD—pre-sleep fasting duration, SD—sleep duration on workdays, postS-FD—postsleep fasting duration, *preSR* and *inSR*. Note, that the main difference between groups is in the postsleep fasting duration changes. (B and C) The summary of changes in times of meals and sleep from *preSR* to *inSR*, by group: panel (B) Alarm/NoAlarm; panel (C) Alarm/Alarm. Last and first meals—turquoise; sleep onset and sleep offset times on workdays—dark blue. The x-axis represents local time in hh:mm format.

and delays of the MF point (on average, by 34 min). Gains in the FD were largest in young adults and decreased with age, in line with the previous report that SR-related changes in sleep behavior decrease with age [35], but there were no differences between the sexes. Improvements were greater in those who stopped using alarm clocks on workdays *inSR*. Much of the sample, who were breakfast eaters *preSR*, extended the FD by 57 min, by both presleep and postsleep FD extensions, in addition to the prolongation of SD on workdays. Breakfast eaters also delayed both their sleep and their mealtimes *inSR*. In contrast, breakfast skippers, 16% of the sample, dramatically shortened their postsleep FD by advancing their first meal of the day, in addition to lengthening their presleep fasting period and SD. In spite of this difference in the response to SRs, the mean FD of the breakfast-skippers was still much longer than the FD of their breakfast-eating peers *inSR* (14.8 h vs. 12.6 h, respectively).

Dietary recommendations regarding *how much* and *what* food to consume have been well-established [45]. However, *when* eating occurs during the 24-h day, which is a topic at the focus of the current chrono-nutrition research, it is increasingly recognized as a significant factor for good health [14, 15, 46–48]. Numerous time-restricted eating studies have shown the benefits of implementing a long fasting window (>13 h) to cardio-metabolic health, including better control of body weight, and lower fasting blood glucose values [1, 49, 50]. In particular, each additional hour of fasting was reported to be associated with a 7% lower risk of cerebrovascular disease [51]. Our study demonstrates that the majority of participants had a natural inclination to prolong the fasting window and align the timing of fasting (pertaining only to eating meals, including snacks) and sleep under relaxed STP. Most participants with a fasting window <14 h *preSR* prolonged it *inSR* (Figure 2, B1, the red dot), suggesting that a FD of 14 h may be a biological set point of the eating/fasting cycle in adults. However, adaptive responses to the unique lifestyle changes and stressors of the pandemic period may have independently influenced eating and sleeping behaviors beyond the simple relaxation of STPs. The tendency to prolong the FD was evident in different countries surpassing time zones and cultures, and across all age groups. Nevertheless, age-related differences were observed, with the youngest age group (18–22 years), reaching the widest fasting window of 14.7 h *inSR*. Our results are in line with the links between eating and sleep behavior reported in several small sample studies during the COVID-19 pandemic [52–54].

Chronotype was significantly associated with FD *inSR*, indicating that under relaxed STP late chronotypes tend to present a fasting/eating behavior promoting longer fasting. Additionally, a later chronotype *preSR* in our sample was associated with breakfast skipping, in line with the literature [55], suggesting that late sleep timing may interfere with social pressures and hinder breakfast consumption, but also with longer FD. Late chronotypes are often recognized as engaged with unhealthy dietary habits related to obesity and less responsive to weight loss interventions [26, 56].

The FD increased universally across different countries by extending the presleep FD and SD: on average, study participants

slept longer *inSR*. When the sample was stratified to breakfast skippers (who had their first meal after 11:00 *preSR*) and breakfast eaters (who had their first meal before 11:00 *preSR*), it was found that breakfast skippers tended to dramatically shorten the postsleep FD (on average, by 1:40 min). As a result, the total FD of breakfast skippers was shorter *inSR* than *preSR*. Nevertheless, breakfast skippers extended the SD and the presleep FD *inSR* to a similar extent as the breakfast eaters and ended up with a still significantly longer FD *inSR* than breakfast eaters (14 h and 50 min vs. 12 h and 40 min, respectively) and no differences in SD. Additionally, among those who worked/studied from home *inSR*, participants who stopped using the alarm clock on workdays showed larger gains in FD, due to larger gains in SD.

Another important consequence of the relaxed STP was the delay of fasting window timing by ~30 min. Recently, a large-scale study that used data from 103 389 adults in the NutriNet-Santé sample has demonstrated that increased risk of cardiovascular disease is associated with later timing of the first and last meals (later than 9:00 and later than 21:00, respectively), especially among women [51]. The authors recommended adopting earlier eating timing patterns and coupling a longer nighttime fasting period with an early last meal, rather than breakfast skipping [51]. However, as Palomar-Cros et al. noted, the association between the first meal timing and the risk of cardiovascular disease was attenuated after considering chronotype. Additionally, several studies outlined that late chronotype is related to poorer eating habits [57], e.g., late chronotypes are prone to breakfast skipping [58, 59], irregular and delayed meal timing [60]. Altogether, these tensions between natural fasting timing preferences and epidemiological health risks underscore the need for individualized fasting schedule recommendations that account for chronotype and social constraints rather than universal meal timing approaches.

When an individual's chronotype is assessed based on sleep-/wake behavior, mid-sleep time is used as the phase-reference of the endogenous rhythm [61]. Since mid-sleep time can be heavily modified by STP, individual chronotype is better measured when people do not use alarm clocks (e.g., via mid-sleep time on free days) and includes a correction for the sleep loss that people experience during the workweek (sleep-corrected MSF, MSF_{sc}) [61]. In the current study, we showed that the phase relationship between MF and chronotype remained constant *inSR* (with MF preceding MSF_{sc} by on average 1.5 h). Moreover, the correlation between them became stronger *inSR* ($\rho_S > 0.7$), and a correlation between MSF_{sc} and FD emerged, not robust *preSR*. The fact that a constant phase relationship between MSF_{sc} and MF is maintained despite the profound changes in the timings of sleep/wake and fasting/eating behavior suggests that both measures reflect chronotype—an individual's phase of entrainment. Based on the current findings, we propose that we can use fasting/eating behavior (meal timing [26, 62]) for assessing an alternative chronotype measurement. Further, we suggest that the assessment basis for "chronotype" should in future be indicated: "sleep/wake chronotype" (CT_{SW}) and "fasting/eating chronotype" (CT_{FE}).

In the interest of maintaining a short questionnaire, we asked only general questions about fasting/eating behavior and did not specify for workdays and free days. Studies of self-reported SD have demonstrated that this approach is essentially assessing sleep habits during workdays [63–65], because people tend to report the most representative days of the week. Indeed, the individual differences between the reported first meal and sleep offset times on workdays were distributed entirely below the zero value (describing eating a first meal after waking up), confirming that reports of habitual meal timings reflect habits during workdays (Supplementary Information 3). Assessing FD separately for workdays and free days may improve the design of future studies by opening novel interesting questions concerning chronotype and its assessment methods through sleep/wake and fasting/eating behavior. For example, what is the relationship between CT_{FE} and age? Does the longitudinal cline, the influence of different sunlight signals at different latitudes on CT_{SW} [66], also exist in CT_{FE}? What can we learn from the differential responses of the respective CT measures to changing conditions (biological, geographical, or social)? What are the relations between "sleep/wake" and "fasting/eating" social jet lags? What are the best predictors of metabolic health: CT_{FE} and SJL_{FE} or CT_{SW} and SJL_{SW}? These questions should be examined under different perturbations in STP, including in populations who experience decoupling in the CT_{SW} and CT_{FE} connection, e.g., shift-work or prolonged repetitive fasting behavior (such as the Ramadan fast). Some of these questions have been unsystematically addressed, e.g., Zerón-Rugerio et al. [29], have found that SJL_{FE} (eating jet lag) is associated with body mass index independently of the CT_{SW} and SJL_{SW} in young adults, but they currently lack a conceptual framework.

There were several limitations to this study. First, there could have been bias in the responses, as our sample was a convenience sample—the survey was distributed online without control over the range of sociodemographic characteristics of the respondents. Second, our data relies on participants recall of eating and sleep behaviors *preSR* and on participants' subjective reflections of their daily routine, which are also subject to bias. Third, our survey did not include questions regarding the content and quantity of food and liquids participants consumed, nor whether dietary choices changed *inSR*. Studies pointed out that during lockdowns, there was an increased snack and alcohol consumption frequency and a preference for sweets and ultra-processed food rather than fruits, vegetables, and fresh food [40]. Therefore, the possible health benefits related to a longer FD reported here might have been offset by poor dietary choices *inSR*. Moreover, the consumption of a high-calorie drink, such as sweetened beverages, milk, or alcohol, would nutritionally be considered a meal; however, there was no independent assessment of such consumption within our questionnaire. Nevertheless, even if this was the case for some participants, it complies with the definition of "fasting" by the International Consensus on Fasting Terminology, which states: "fasting is a voluntary abstinence from some or all foods or foods and beverages" [67]. Fourth, the reported habitual meal timings in the current study can be considered as reflecting the eating habits during workdays (see Supplementary Information 3 for justification). Fifth, we did not obtain many other relevant variables, such as health, family status, and number of children, and many others. Finally, SRs differed significantly between countries, for example, directly affecting the opportunity to be exposed to daylight and creating diversity in the way lockdowns were experienced by participants. Nevertheless, the rare opportunity provided by SRs during the COVID-19 pandemic enabled us to gain new insight into people's behavior under relaxed STP in situ, without the resource heavy, nonecological alternatives used hitherto. This provides strong evidence of the natural occurrence of changes in fasting/eating behavior after sufficient time provided to the acclimatory stage. The international collaboration at the basis of the survey allowed a broad cross-cultural picture: in response to the relaxed STP *inSR*, the habitual FD tended to increase more than SD on workdays in different countries around the globe. Moreover, while the presleep FD increased in most countries, changes in the postsleep FD were mostly insignificant (see Supplementary Information 4).

We conclude that relaxed STP naturally promotes a longer FD and co-alignment of the daily eating and sleeping cycles. The cross-cultural consistency of these changes supports previous findings of spontaneous temporal reorganization when artificial constraints are removed, as demonstrated in controlled studies like the "Colorado camp experiment" [68]. The pandemic's SRs provided a unique opportunity to observe these principles operating at scale within participants' natural social contexts, overcoming the ecological limitations of traditional laboratory-based chronobiology research. Despite large changes in sleep and mealtimes from pre- to during SRs, the phase relationship between mid-sleep and mid-fasting was remarkably robust in our cohort. This robustness suggests an underlying "daily sleep-fasting structure" (DSFS) that may anchor behavioral adaptations during schedule transitions. Similar to social jetlag, DSFS could serve as a biobehavioral marker linking STPs with sleep and metabolic health outcomes. Current findings have important implications for public health policy, suggesting that modern norms in social schedules constrain the natural interaction between sleep and fasting cycles. Greater temporal flexibility in social schedules may support optimal sleep-fasting alignment and improve population health outcomes among working and studying adults.

Supplementary material

Supplementary material is available at *SLEEP* online.

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Author contributions

M.K. and T.R. designed research; M.K., V.T., and T.R. performed research; M.K., T.R., C.R., Y.K., D.G., and V.K. contributed translations of the GCCS to different languages and advertised the study in their countries; M.K., C.F., V.T., and T.R., analyzed data; M.K., C.F., V.T., C.R., Y.K., S.K., D.G., V.K., and T.R. wrote the article.

Disclosure statement

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Data availability

We included all the data needed for the evaluation of the conclusions in the Results section or in the Supplementary Information file. Additional data related to this article may be requested from the authors.

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SLEEP, 2025, **48**, 1–13
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