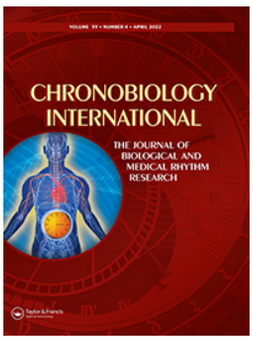

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Young people and adolescents have more irregular meals during the COVID-19 pandemic: A nested case-control study on chrono-nutrition before and during the COVID-19 pandemic

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ABSTRACT

Chrono-nutrition is an emerging field of research that includes three aspects of time: (1) regularity, (2) frequency, and (3) clock time. Due to the COVID-19 pandemic and the implemented lockdown, daily routines were disrupted, which presented a unique opportunity to investigate chrono-nutrition, in particular in adolescents. A nested case-control study was conducted and information on chrono-nutrition was collected via an anonymous online questionnaire including 99 participants aged 13 to 20 years (N = 43 before the COVID-19 pandemic and N = 56 during the COVID-19 pandemic). Differences in chrono-nutrition were tested with chi-square and Mann–Whitney U. During the COVID-19 pandemic, participants consumed their breakfast less regularly (34%) compared with participants before the COVID-19 pandemic (65%) (P = .003). Additionally, during the COVID-19 pandemic, participants consumed snacks in the morning (26% vs. 60%, P = .001), afternoon (19% vs. 81%, P < .000), and evening (22% vs. 84%, P < .001) less regularly. However, the frequency in afternoon (4.9 ± 2.2 times per week vs. 3.8 ± 1.9 times per week, P = .002) and evening snacks (4.4 ± 2.4 times per week vs. 3.4 ± 2.0 times per week, P = .02) was higher for participants during the COVID-19 pandemic. We also observed that participants reported more sleeping problems during the COVID-19 pandemic (34% vs. 14%; P = .07). This study in 99 young people and adolescents suggests that meal regularity declined during the COVID-19 pandemic, while meal frequency, especially snack consumption, increased. This highlights the importance of maintaining a regular daily structure to avoid excessive energy intake via snacks.

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Introduction

It is becoming evident that besides the quality and quantity of food (Jiménez-Chillarón et al. 2012; National Research Council 1989), the timing of food consumption plays a crucial role in health (Ruddick-Collins et al. 2018a, 2018b; West and Bechtold 2015). The importance of when we eat relates to our biological clock. Our endogenous circadian cycle is close to a 24 h cycle (Skene and Arendt 2006). However, our environment is run exactly at a 24 h cycle; therefore, the biological clock needs to be continuously synchronized. Cues capable of entraining circadian rhythms (also called 'zeitgebers') include diurnal alternations between light/dark periods, physical activity, and the timing of food consumption (Challet 2019; Flanagan et al. 2020a; Revell and Eastman 2005). Interrupted, inconsistent or weak zeitgebers can lead to circadian misalignment, resulting in reduced fitness or various pathologies, including metabolic syndrome (Reinke and Asher 2019; Roenneberg and Merrow 2016). Evidence suggests that time-restricted feeding (TRF; < 10 hours food access in the active phase) might be a potential tool to counteract chronodisruption, and consequently, metabolic disease, as it may have a positive effect on the synchronization of the biological clock (Chaix et al. 2019, 2014). The emerging field of research that studies the complex interactions between the biological clock, timing of food consumption, and metabolic health is called chrono-nutrition (Flanagan et al. 2020b; Ruddick-Collins et al. 2018a; Tahara and Shibata 2013).

Chrono-nutrition includes three aspects of time: 1) regularity, 2) frequency and 3) clock time (Pot et al. 2014). All these elements may influence circadian cycles or vice versa (Bechtold and Loudon 2013). For instance, regular feedings synchronize the circadian system, while irregular feedings, like breakfast skipping, may cause circadian misalignment (Erren and Reiter 2009). Skipping breakfast is most prevalent in adolescents and is associated with health concerns such as insomnia and impaired school performance (Berkey et al. 2003; Erren and Reiter 2009).

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The COVID-19 crisis and the implemented lockdown strongly affected everyone's daily life. For some people, their daily routine may have been disrupted (Boaventura et al. 2021). Social distancing, interruption of regular school routines, and lack of the typical outlets, including gym workouts, travels, and outings with friends, can be especially challenging for adolescents (Xiang et al. 2020). Therefore, this presented a unique opportunity to investigate the possible impact of the COVID-19 pandemic on temporal eating patterns, i.e. chrono-nutrition of adolescents.

From a chronobiological point of view, people may have struggled to maintain a healthy lifestyle during quarantine, and this may increase the risk of obesity, which is partly associated with a misalignment of the biological clock (Boaventura et al. 2021).

Moreover, research suggests unhealthy eating habits, overindulgent and altered alcohol consumption were more present during the COVID-19 pandemic and the corresponding measures (Chodkiewicz et al. 2020; Huber et al. 2020). However, a recent study showed that 22% of the Dutch population ate healthier due to the pandemic, while only 12% of the population turned to less healthy eating habits (Poelman et al. 2021). This study showed that young adults were more prone to change their dietary behavior, both healthier and unhealthier, during the COVID-19 lockdown (Poelman et al. 2021). Therefore, the primary aim of this study was to investigate the impact of the COVID-19 pandemic on chrono-nutrition in young people and adolescents aged 13 to 20 years.

Methods

Study population

The study "Sleep, nUtrition, eating and delayed Sleep PhasE Disorder iN aDolesecents" (SUSPEND study) is an ongoing observational case-control study concerning chrono-nutrition. The cases of this case-control study were participants aged 13 to 20 years diagnosed with Delayed Sleep Phase Disorder (DSPD) at Hospital Gelderse Vallei (Ede, NL). The control group consisted of age-equivalent participants. Previous research described differences in chrono-nutrition and diet quality in participants with DSPD compared to age-related controls (Berendsen et al. 2020).

The current nested case-control study specifically focused on chrono-nutrition in healthy controls and the possible impact of the COVID-19 pandemic on chrono-nutrition in participants.

Participants were recruited via personal networks and high schools. The inclusion criteria of the study population were aged between 13 and 20 years and living in the Netherlands. Exclusion criteria were the use of melatonin or other medications that affect sleep. Data for this study before the COVID-19 pandemic were collected between October 2013 and August 2020. Data for this study during the COVID-19 pandemic were collected between September 2020 and August 2021. The questionnaires before the COVID-19 pandemic were mostly completed at school in a classroom setting. However, during the COVID-19 pandemic, the questionnaires were mainly completed at home or during online classes.

The study was approved by the Beoordelings-Commissie Wetenschappelijk Onderzoek (BCWO) of Hospital Gelderse Vallei (Boelsma 2017).

Demographics assessment

Information about sex, age, education, height, weight, disorders, smoking habits, potential sleeping problems, and melatonin use of the controls was obtained through an online questionnaire. Height and weight were self-reported by the participants and BMI (in kg/m^2) was subsequently calculated. The physical activity of the participants was assessed by two questions about the frequency (no physical activity, 1 day/week, 2 days/week, 3 days/week, 4 days/week, 5 or more days/week) and duration of moderate physical activity (1–10 minutes, 10–20 minutes, 20–30 minutes, and 30 minutes or more).

Chrono-nutrition assessment

To measure chrono-nutrition, a 23-item questionnaire encompassing meal regularity, meal frequency, and meal clock time was used. Questions were based on questionnaires and literature from other studies about the relationships between chrono-nutrition, metabolic syndrome, and the biological clock (Mota et al. 2008; Sierra-Johnson et al. 2008; Szeinberg et al. 2006). This questionnaire also contained questions on the speed of consuming meals and whether participants overconsume during meals.

Dietary consumption assessment

We collected data on dietary consumption using questionnaires based on the Eating Choices Index (ECI)(Pot et al. 2013). Additionally, we collected the frequency of consumption of healthy (i.e. fruit, vegetable, and raw vegetable) and unhealthy snacks (i.e. cookies, chips, and cake/pie). Furthermore, we explored alcohol

consumption, including alcohol consumption on weekdays (amount of days and glasses) and alcohol consumption on the weekends (amount of days and glasses). Additionally, we asked about the frequency of often consumed foods based on questions from the Dutch Healthy Diet index (DHD-index)(L. Van Lee et al. 2012).

Statistical analysis

The collected data were stored, managed, and analyzed using Microsoft Excel and IBM SPSS statistics, version 26.0, and a P value of $P < .05$ was considered statistically significant. Baseline characteristics were presented as means ± standard deviations, or as numbers (n) and percentages (%). Non-normal distributed data were presented as median and interquartile range. Differences in chrono-nutrition in participants before and during the COVID-19 pandemic were calculated using non-parametric tests. Meal regularity was calculated using the chi-square test. Meal frequency and clock time were calculated using the Mann–Whitney U test. We checked for effect modification of sex and sleeping problems during the COVID-19 pandemic.

Results

Characteristics of the study population

The study population included 99 participants (N = 43 before the COVID-19 pandemic and N = 56 during the COVID-19 pandemic). There were slightly more boys in the study population before the COVID-19 pandemic (58% boys) compared with during the COVID-19 pandemic (45%) (Appendix, Table A1). Hence, we explored possible effect modification by sex and observed differences between boys and girls in the regularity in afternoon- (P = .001) and evening snacks (P = .000). In addition, both lunch (P = .038), dinner (P = .000), afternoon- (P = .003) and evening snack frequency (P = .048) differed. The educational level of participants before the COVID-19 pandemic was on average higher (49% pre-university education) compared with the educational level of participants during the COVID-19 pandemic (56% pre-vocational secondary education). Differences in chrono-nutrition and educational levels showed significant differences for regularity in afternoon (P = .014)- and evening snacks (P = .015). In addition, dinner frequency (P = .001) and lunchtime (P = .004) were significantly different. The number of participants with self-reported sleeping problems was remarkably but not statistically significantly higher during the COVID-19 pandemic (34%) compared with before the COVID-19 pandemic (14%) (P = .07).

Chrono-nutrition and COVID-19

Results on chrono-nutrition before and during the COVID-19 pandemic are presented in meal regularity (Figure 1), meal frequency (Figure 2), and clock time.

Meal regularity

During the COVID-19 lockdown, participants consumed their breakfast less regularly (34%) compared with participants before the COVID-19 pandemic (65%) (Figure 1; P = .003). For snack regularity, participants consumed morning snacks during the COVID-19 pandemic less regularly (26%) compared with before the COVID-19 pandemic (60%) (P = .001). In addition, afternoon snacks (19%) were consumed less regularly

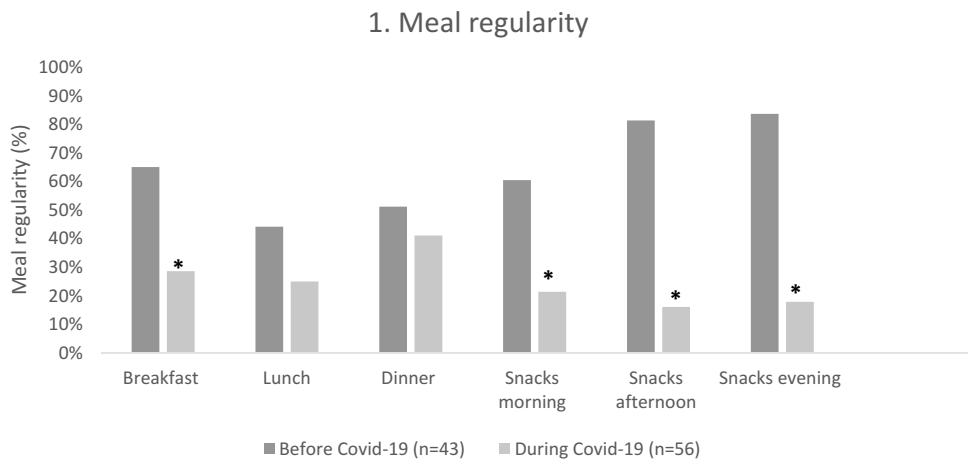

Figure 1. The percentage of meal consumption at regular times in adolescents before COVID-19 (N = 43) and adolescents during COVID-19 (N = 56). Results are represented as mean. A Chi-square test was performed to compare meal regularity in adolescents before COVID-19 with adolescents during COVID-19. * $p < .05$.

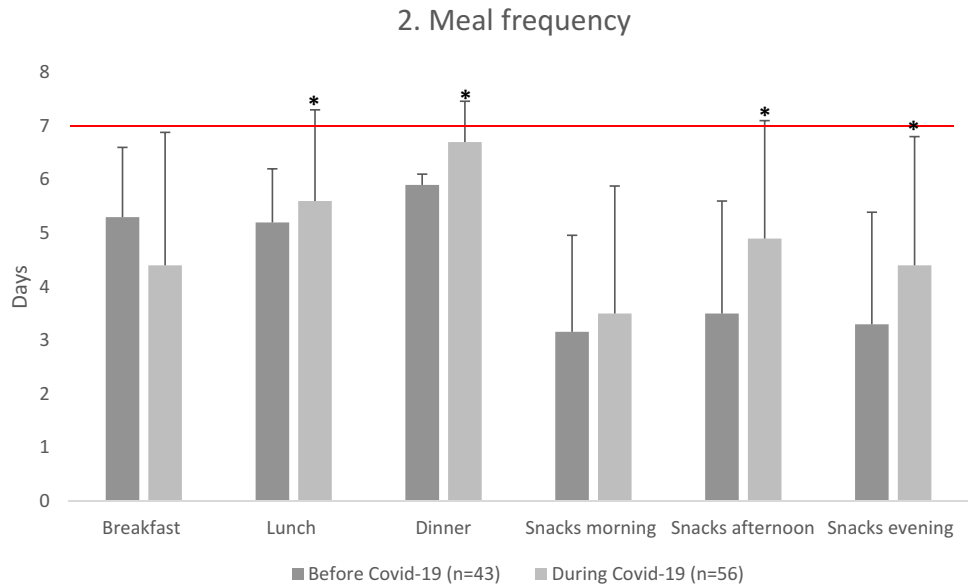

Figure 2. Meal frequency (times per week) of adolescents before COVID-19 (N = 43) and adolescents during COVID-19 (N = 56). Results are represented as mean ± SD. Mann-Whitney U test was performed to compare meal frequency in adolescents before COVID-19 with meal frequency during COVID-19. * $p < .05$.

during the COVID-19 pandemic compared with before the COVID-19 pandemic (81%) ($P < .001$). Also, evening snacks were consumed less regularly during the COVID-19 pandemic (22%) than before the COVID-19 pandemic (84%) ($P < .001$). The results show a trend toward a less regular breakfast and snack consumption in participants during the COVID-19 pandemic compared with those before the COVID-19 pandemic.

Meal frequency

Participants consumed lunch more frequently during the COVID-19 pandemic (5.6 ± 1.7 times per week) compared with participants before the COVID-19 pandemic (5.2 ± 1.0 times per week) ($P = .016$) (Figure 2). Moreover, participants consumed dinner more frequently during the COVID-19 pandemic (6.7 ± 0.8 times per week) compared with before the COVID-19 pandemic (6.0 ± 0.2 times per week) ($P < .001$). Participants consumed snacks more frequently in the afternoon and evening during the COVID-19 pandemic (4.9 ± 2.2 and 4.4 ± 2.4 times per week, respectively) compared with before the COVID-19 pandemic (3.8 ± 1.9 and 3.4 ± 2.0 times per week, respectively) ($P = .002$ and $P = .02$, respectively).

Clock time

We observed a minor but not statistically significant shift toward later meal consumption in participants during the COVID-19 pandemic compared with participants before the COVID-19 pandemic. Especially, foods consumed during the weekend seemed to be consumed somewhat, but not statistically significantly later. The first meal of the day was consumed at 9:45 ± 0:53 during the COVID-19 pandemic vs. 9:12 ± 0:47 before the COVID-19 pandemic ($P = .095$) and the last meal during the weekend was consumed at 22:15 ± 0:53 during vs. 21.32 ± 1:11 before the COVID-19 pandemic ($P = .195$).

Sleeping problems and COVID-19

As we observed that slightly more participants experienced sleeping problems compared with before the COVID-19 pandemic, we also explored the chrono-nutrition of participants with and without sleeping problems. Participants with sleep problems consumed dinner less regularly (21.1%) compared with normal sleepers (52.8%) ($P = .043$) (data not shown). Breakfast was consumed less frequently by participants with sleeping problems (3.8 ± 2.5 times per week) compared with normal sleepers (4.7 ± 2.4 times per week). Afternoon snacks were also consumed less frequently by participants with sleeping problems (3.6 ± 2.8) compared with normal sleepers (5.6 ± 1.5) ($P = .022$). When considering clock time, we observed an earlier breakfast consumption in participants with sleeping problems (7:1 ± 00:17 vs. 7:45 ± 0:10)($P = .321$)(N = 20). Additionally, lunchtime was slightly earlier in participants with sleeping problems compared with normal sleepers (12:30 ± 00:00 vs. 12:41 ± 0:15)(N = 29).

Dietary consumption

Overall, we did not observe a statistically significant difference in diet quality as measured by the ECI ($P = .12$). Fewer participants reported consuming too

much during meals during the COVID-19 pandemic (P = .02) (Table 1). No differences were observed in the speed of consuming meals before and during the COVID-19 pandemic (P = .50).

We explored the consumption of healthy snacks (fruit, vegetable, raw vegetable) and unhealthy snacks (crips, cookies, cakes/pie) before and during the COVID-19 pandemic (Table 1). These results suggest slightly higher consumption of both healthy and unhealthy snacks during the COVID-19 pandemic compared with before the COVID-19 pandemic

Results suggested that the frequency of alcohol consumption on weekdays was higher during the COVID-19 pandemic (Table 1). However, the total amount of alcohol consumption on weekdays decreased (before COVID-19: 4.7 ± 1.2 glasses/weekdays vs. during the COVID-19 pandemic: 2.0 ± 0.8 glasses/weekdays) (Table 1).

Discussion

The current study investigated chrono-nutrition in young people and adolescents before (N = 43) and during N = 56 the COVID-19 pandemic). Results showed that participants consumed meals less regularly during the COVID-19 pandemic compared with those before the COVID-19 pandemic. However, the frequency of lunch, dinner, and snacks was higher in participants during the COVID-19 pandemic. Most meals seemed to be consumed at a later clock time during the COVID-19 pandemic. These results suggest participants developed a less structured eating schedule during the COVID-19 lockdown and we also observed that more participants experienced sleeping problems during the COVID-19 pandemic.

The observed trend toward a less regular eating pattern during the COVID-19 pandemic might be explained by the lack of structure and routine that school normally provides to the lives of scholars. During the COVID-19 pandemic, adolescents have experienced greater freedom, since they could organize their day and balance their eating moments. This may also explain the increased snack consumption during the COVID-19 pandemic. We explored the type of snack, i.e. healthy (fruit, vegetable, raw vegetable) and unhealthy snack (chips, cookie, cake/pie), and found a slight increase of both healthy and unhealthy snacks. This might partially result from people's snacking behavior changing over time as the longer lockdown continues (Lim 2020). The findings agree with the research of Poelman et al., who indicated that younger participants, aged between 18 and 30 years, changed their dietary behavior, both healthier and unhealthier, during the COVID-19 pandemic. (Poelman et al. 2021).

Results on meal frequency showed a higher frequency of lunch, dinner, and snack consumption in participants during the COVID-19 pandemic. These findings seem in line with the research of King et al., who determined that a major part of the population increased their energy intake and expanded the daily eating window during the COVID-19 lockdown (King et al. 2020). The expanded eating window might also be related to the later meal times that we observed during the COVID-19 pandemic. However, during the pandemic, delayed sleep onset was observed (Lee et al. 2021) and this could also lead to a larger eating window. The observed increase in meal frequency is in line with a recent study that showed dietary changes, increased food consumption, and unhealthy food choices, in children, adolescents, and young adults during the COVID-19 pandemic (Stavridou et al. 2021).

Additionally, the increase in meal frequency during the COVID-19 pandemic might also be related to participants spending more time at home. Many sports activities, such as football training in the evening, were canceled during the lockdown, which may have led to more frequent meal consumption at home.

Chrono-nutrition and sleep problems

We observed a higher self-reported number of sleeping problems during the COVID-19 pandemic (34% vs. 14%). Though this difference was not statistically significant, we did find this remarkable.

The increase in sleeping problems during the COVID-19 pandemic is consistent with a meta-analysis of Jahrami et al., who indicated that approximately 40% of the population experienced sleeping problems during the COVID-19 pandemic. (Jahrami et al. 2021). Additionally, a survey among Dutch scholars (12 to 18 years) showed 28% suffer from poor sleep quality during the COVID-19 pandemic ("Resultaten Coronapeiling Jeugd" 2021). The main reasons were stress, absence of an outlet, and disruption of daily rhythms.

Adolescents and young adults tend to shift their chronotype toward a later type (Roßbach et al. 2018). However, the covid19 pandemic may have shifted the chronotype even later. This might be related to the increase in irregular meal intake observed during the COVID-19 pandemic, as irregular meal intake may induce chronodisruption (Challet 2019). In addition, previous research has shown that chronodisruption is associated with a higher prevalence of sleep disorders (Yamanaka 2020). A potential strategy to prevent or treat sleep disturbances might be intermittent fasting, in particular TRF (Currenti et al.

Table 1. Dietary components of adolescents before (N = 43) and during (N = 56) the COVID-19 pandemic of the Sleep, nUtrition, eating and delayed Sleep PhasE Disorder iN aDolesecents (SUSPEND) study. Values are presented as mean ± SD or as n (%). Foods were indicated consumed as number of days per week.

	Before COVID-19 (N = 43)	During COVID-19 (N = 56)	*p* value *
Diet quality (ECI score)*	12.7 ± 1.9	11.6 ± 2.3	0.12
Alcohol consumption *(N* (%))**			
Weekdays	1 (2.3%)	13 (23.2%)	
Missing values	35 (81.4%)	13 (23.2%)	
Weekends	4 (9.3%)	10 (17.8%)	
Missing values	29 (67.4%)	42 (75%)	
Selection of healthy foods (N (%))**			
Fruit, 2 portions per day			0.07
< 1 day per week	13 (30%)	8 (18%)	
1–2 days per week	12 (28%)	12 (27%)	
3–4 days per week	14 (33%)	12 (27%)	
5–6 days per week	4 (9%)	9 (20%)	
7 days per week	0 (0%)	4 (9%)	
Vegetables			
< 1 day per week	14 (33%)	9 (20%)	0.34
1–2 days per week	10 (23%)	14 (30%)	
3–4 days per week	12 (28%)	14 (30%)	
5–6 days per week	7 (16%)	7 (15%)	
7 days per week	0 (0%)	2 (4%)	
Raw vegetables			0.24
< 1 day per week	20 (47%)	13 (29%)	
1–2 days per week	13 (30%)	10 (22%)	
3–4 days per week	7 (16%)	12 (27%)	
5–6 days per week	3 (7%)	7 (16%)	
7 days per week	0 (0%)	3 (7%)	
Selection of unhealthy foods (N (%)) **			
Crisps			0.004
< 1 day per week	33 (77%)	16 (36%)	
1–2 days per week	10 (23%)	21 (27%)	
3–4 days per week	0 (0%)	5 (11%)	
5–6 days per week	0 (0%)	2 (4%)	
7 days per week	0 (0%)	1 (2%)	
Small cookies			0.37
< 1 day per week	12 (28%)	13 (29%)	
1–2 days per week	16 (37%)	10 (22%)	
3–4 days per week	9 (21%)	10 (22%)	
5–6 days per week	6 (14%)	9 (20%)	
7 days per week	0 (0%)	3 (7%)	
Large cookies, cakes, or pie			0.184
< 1 day per week	28 (65%)	21 (47%)	
1–2 days per week	11 (26%)	15 (33%)	
3–4 days per week	4 (9%)	5 (11%)	
5–6 days per week	0 (0%)	1 (2%)	
7 days per week	0 (0%)	3 (7%)	
General question regular meals			0.14
(N (%))**	3 (7%)	2 (4%)18 (37%)	
I eat every meal at the same time	24 (56%)	15 (31%)	
Most days (not 1–2 days/week)	11 (26%)	14 (29%)	
Some days (> 3 days irregular)	5 (12%)		
All meals irregular			
Meal speed (N (%))**			0.50
I consume my meals slowly	6 (14%)	6 (12%)	
I consume my meals at an average speed	24 (56%)	21 (43%)	
I consume my meals quickly	11 (26%)	17 (35%)	
I don't know	2 (5%)	5 (10%)	
Overconsumption (N (%))**			0.02
I never eat too much	20 (47%)	18 (37%)	
< 1 time per week I eat too much	12 (28%)	12 (24%)	
2–3 times per week I eat too much	1 (2%)	4 (8%)	
> 4 times per week I eat too much	7 (16%)	3 (6%)	
I don't know	3 (7%)	12 (26%)	

* Independent sample t-test was used. ** Chi-square test was used. Statistical significance at $p < 0.05$

2021). Additionally, sleep problems might be related to the unlimited use of electronics and screen time during the COVID-19 pandemic. Spending disproportionate time in screen-based activities might negatively impact sleep quality and food intake (Boaventura et al. 2021). Overall these findings are in accordance with findings reported by Teixeira *et al*, who showed that adolescents were exposed to longer screen time and an inadequate sleeping pattern during the COVID-19 pandemic (Teixeira et al. 2021).

Results suggested that meal regularity and frequency were lower in participants with sleep problems. Our findings are partly in agreement with the results of Mazri et al., who showed that participants with a later midpoint of sleep tended to skip breakfast more often (Mazri et al. 2020). However, further research with larger sample size is necessary to explore the potential association between chrono-nutrition and sleep problems during the COVID-19 pandemic.

Strengths and limitations

This study was limited as the questionnaires completed during the COVID-19 pandemic were not as complete as before the COVID-19 pandemic. Many questions were skipped, and this might be related to the somewhat different setting in which the questionnaires were completed before and during the COVID-19 pandemic. Before the COVID-19 pandemic, questionnaires were mostly completed in a classroom, while during COVID-19 questionnaires were mostly completed at home or during online classes. Moreover, the questionnaire during the COVID-19 pandemic contained seven additional questions about chronotype, which were beyond the scope of this research. However, this might have impacted the response rate.

The demographic characteristics of participants who completed the survey before and during the COVID-19 pandemic were slightly different, e.g. educational level, disorders, and age. In addition, this study had a relatively small sample size. Therefore, it was not possible to correct for covariates, such as education and age. Future studies could include larger sample size and correct for potential confounders. Another limitation in this study involves the issue of seasonal variation. The data collection was carried out during all months of the year. However, we did not consider the month of record and therefore, seasonal variations might have affected the results of this study. A previous study described girls having higher seasonal sensitivity from the age of 14 years compared to boys (Tonetti et al. 2007). Craving high-calorie food may be a symptom of Winter Seasonal Affective Disorder. Subsequent research in 2012 revealed a significant relationship between eveningness and higher mood seasonality in adolescents between 10 and 17 years (Tonetti et al. 2012).

The strengths of this study include that we collected data on chrono-nutrition by using validated questionnaires and this resulted in reliable and in-depth information on chrono-nutrition (Pot et al. 2013). Additionally, the participants included in this study form a relatively good representation of the Dutch adolescent population, since we included different ages, genders, educational levels, disorders, and participants who lived in different Dutch provinces (including Limburg, Utrecht, Brabant, Gelderland). Furthermore, chrono-nutrition is an emerging field of research, and this study is one of the first descriptive studies on chrono-nutrition and COVID-19. Moreover, one of the innovative aspects of this study was that we explored chrono-nutrition and sleep problems during the COVID-19 pandemic.

In conclusion, we observed several differences in chrono-nutrition before and during the COVID-19 pandemic. However, the findings of this study should be interpreted with caution due to the small sample size (N = 99). Generally, meal regularity declined during the COVID-19 pandemic, while meal frequency, especially snack consumption, increased. This suggests participants lost their daily structure and were more likely to skip meals and consume snacks instead. This highlights the importance of maintaining a regular daily structure to avoid excessive energy intake via snacks, especially with the ongoing obesity endemic.

Disclosure statement

The authors report no conflict of interest. The authors alone are responsible for the content and drafting of this paper.

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Appendix

Table A1. Baseline characteristics of adolescents before (N = 43) and during (N = 56) the COVID-19 pandemic of the Sleep, nUtrition, eating, and delayed Sleep PhasE Disorder iN aDolesecents (SUSPEND) study. Values are presented as mean ± SD or as n (%).

	Before COVID-19 (N = 43)	During COVID-19 (N = 56)
Sex *N* (percentage)		
Boys	25 (58.1%)	25 (44.6 %)
Girls	18 (41.9%)	27 (48.2 %)
Other	0 (0%)	4 (7.1%)
Age (years)	15.5 ± 1.2	16.0 ± 1.8
Height (cm)	175.4 ± 9.3	172.4 ± 10.9
Weight (kg)	62.6 ± 9.3	62.9 ± 12.9
BMI (kg/m^2)	20.3 ± 2.6	21.0 ± 3.6
Educational level *N* (percentage)		
Pre-vocational secondary education	6 (14.0%)	29 (51.5%)
Senior general secondary education	16 (37.2%)	7 (12.5%)
Pre-university education	21 (48.8%)	11(19.6%)
Different types of education	0 (0%)	9 (16.1%)
Disorders *N* (percentage)		
ADHD	1 (2.3%)	7 (12.5%)
Dyslectic	2 (4.7%)	8 (14.3%)
Highly Intelligent	2 (4.7%)	0 (%)
Autism	1 (2.3%)	2 (3.6%)
Depression	1 (2.3%)	0 (0%)
Perfectionism	2 (4.7%)	4 (7.1%)
Other	1 (2.3%)	3 (5.4%)
No disorder	1 (2.3%)	14 (25%)
Combination of above	0 (0%)	8 (14.3%)
Missing values	32 (74.4%)	10 (17.9%)
Smoking N (percentage)		
Yes	2 (4.7%)	6 (10.7%)
No	41 (95.3%)	42 (75%)
Missing values	-	8 (14.3%)
Sleeping problems N (percentage)		
Yes	6 (14%)	19 (33.9%)
No	29 (67.4%)	36 (64.3%)
Missing values	8 (18.6%)	1 (1.8%)
Physical activity (days)		
No exercise	1 (2%)	4 (9%)
1 day per week	6 (14%)	2 (4%)
2 days per week	3 (7%)	8 (18%)
3 days per week	4 (9%)	14 (31%)
4 days per week	29 (67%)	6 (13%)
5 or more days per week	0 (0%)	11 (24%)
Physical activity (minutes)		4 (7.1%)
1 - 10 min	1 (2.3%)	
10 - 20 min	5 (11.6%)	2 (3.6%)
20 - 30 min	11 (25.6%)	8 (14.3%)
> 30 min	26 (60.5%)	30 (53.6%)
Missing values	-	12 (21.4%)