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Research article

Relationships of the duration of working from home with obesity, obesity-related behaviors, physical activity, and stress level in workers in an academic institution during the COVID-19 pandemic

Saimai Chatree*, Jariya Buniam, Patcharee Yakasem, Anyamanee Chaiprasongsuk

[1] *Princess Srisavangavadhana College of Medicine, Chulabhorn Royal Academy, Bangkok, Thailand*

*Corresponding Author: E-mail: saimai.cha@cra.ac.th

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Abstract

Background: Obesity is caused by an energy imbalance and predisposes toward the development of comorbidities. During the COVID-19 lockdown, behavioral changes may have disrupted energy balance. Previous studies have shown overeating, lower physical activity, and more substantial mental health issues in adults during such a lockdown. However, the relationships of working from home (WFH) with obesity-related parameters, including behaviors, might differ according to individual circumstances. Therefore, in the present study, we aimed to characterize the relationships of WFH during the initial COVID-19 lockdown on the obesity, stress level, physical activity, and obesity-related behaviors in workers at an academic institution in Thailand.

Methods: We evaluated these parameters using an anonymous online questionnaire.

Results: We found that the body weight ($p < 0.05$) and body mass index (BMI; $p < 0.05$) of participants who had worked from home were significantly higher after 15 days of the WFH. Similarly, those who had worked from home for 30 days reported that their BMIs had also increased ($p < 0.05$). The frequency of food delivery was significantly lower in participants who had worked from home for 60 days ($p < 0.05$) and for >60 days ($p < 0.05$) than in the 30-day WFH group. In addition, the stress level of the 30-day WFH group was higher than that of the 15-day WFH group ($p < 0.05$), but lower than that of the 60-day WFH group ($p < 0.05$).

Conclusions: In conclusion, WFH for a short period of time was associated with increases in body weight and BMI, and changes to obesity-related behaviors. These changes in physical parameters were found to be associated with changes in stress level. These findings may be helpful for the creation of guidelines regarding the preservation of both the physical and mental health of workers during lockdowns. The energy provided by the various sources of nutrition should be assessed in the future because these are important for the bioenergetics and weight gain of workers during such a lockdown.

Keywords: obesity, COVID-19, working from home, physical activity, stress level, worker

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Introduction

The prevalence of obesity in adults of both sexes has increased during recent decades[1]. Obesity is associated with higher risks of comorbidities and mortality[2, 3], and thus represents a substantial public health burden. Obesity is frequently defined using a body mass index (BMI) of ≥30 kg/m^2 for Caucasian populations[4] and ≥25 kg/m^2 for Asia-Pacific populations[5, 6]. The BMI cut-off values for each of these population is defined differently because the health risks, including of various non-communicable diseases, and the mortality rate vary significantly among ethnic groups[7, 8]. In Thailand, the prevalence of obesity significantly increased from 33.9% to 44.8%, and the mean BMI increased from 23.9 kg/m^2 to 25.0 kg/m^2 between 2012 and 2018[9]. Energy homeostasis is vital to the regulation of body mass status[10].

The emergence of coronavirus disease 2019 (COVID-19) was followed by it officially becoming a pandemic in March 2020, and the first wave of the disease was considered to have occurred in Thailand between January and July 2020[11]. During the pandemic, most office workers were required to work from home, to maintain physical distancing and reduce the spread of the disease. This disrupted workers' lifestyles and may have deleteriously affected their energy balance, thereby increasing obesity. A previous study of self-reported data showed that individuals gained weight after the first month of the enforced lockdown during the pandemic[12, 13]. Another study showed higher BMI, associated with lower dietary quality and physical activity, and a higher prevalence of overeating during the lockdown[14].

The initial COVID-19-related lockdown was also found to be associated with adverse effects on mental health[12]. Psychological analysis showed a positive correlation between physical activity and the prevalence of mental health problems, consistent with the findings of previous study, which showed an association between stress and the increase in BMI during lockdown[15, 16]. During the spread of the SARS-CoV-2 virus in 2020, people reported experiencing high levels of stress, anxiety, and mental health problems[17]. Moreover, a previous study showed that those either with or without a diagnosis of a psychiatric condition gained weight and reported more nocturnal food consumption during lockdown[18], which implies that the body weight gain occurred independently of mental health status. Thus, an increasing amount of evidence suggests that the initial lockdown, which was enforced because of the COVID-19 pandemic, was associated with increases in body mass, abnormal eating behaviors, and mental health problems.

Previous studies have also revealed that people with severe obesity are more vulnerable to SARS-CoV-2 infection because of higher expression of the angiotensin-converting enzyme 2 receptor[19, 20]. These data imply that obesity was not conducive to health during the COVID-19 pandemic. However, the enforced lockdowns may have had differing effects on body mass and obesity-related behaviors, according to the duration of the measures, employment status, and attitudes to the pandemic. To date, no studies have focused on the relationships of WFH with obesity-related parameters, including behaviors, during the initial COVID-19 lockdown in workers in academic institutions in Thailand. Therefore, in the present study, we aimed to characterize the relationships of WFH with obesity-related parameters, stress level, physical activity, and obesity-related behaviors during the initial COVID-19 lockdown in workers at an academic institution. The results should provide information regarding the risks of obesity and changes in obesity-related behaviors under such circumstances, and thereby help prevent obesity and ensure good health.

Methods

Ethical considerations

The study protocol was approved by Human Research Ethics Committee, Chulabhorn Research Institute (project code 036/2563), and conformed with the principles of the Declaration of Helsinki[21]. Prior to responding to the questionnaire, the eligible participants had the research objectives and procedures, the procedures to ensure confidentiality, the risks and benefits, their contribution, and their rights to refuse to participate or withdraw from the study explained to them. All the participants then provided their written informed consent. Throughout the study, the anonymity of the participants was protected using code numbers.

Study design

We performed a cross-sectional descriptive study at the Princess Srisavangavadhana College of Medicine, Chulabhorn Royal Academy. We used social media to randomly distribute anonymous online questionnaires to workers at Princess Srisavangavadhana College of Medicine between 3 July 2020 and 3 March 2021. The required sample size was calculated using the Taro Yamane Formula, the sampling error was set as 0.05, and random sampling was used as the sampling technique. Individuals >20 years old were recruited by an online panel and asked to provide their informed consent before participating. We collected data using an online survey and recorded these in an Excel file for analysis.

The exclusion criteria were pregnancy, lactation, metabolic diseases (e.g., diabetes mellitus, Cushing's syndrome, and hypo/hyperthyroidism), and the use of any medication for the treatment of overweight or obesity. Ninety-one individuals completed the questionnaire, of whom 78 remained after the application of the exclusion criteria. The 13 individuals who were not eligible for the study were pregnant (n=2), using a medication to treat overweight or obesity (n=3), or had a metabolic disease (n=8).

Questionnaire

We developed a questionnaire that consisted of 29 multiple-choice and short-answer questions. The questionnaire was divided into two parts, reflecting the status of the respondents before and after WFH, to identify the changes that occurred between these time points. The results were analyzed according to the length of the WFH period: 15, 30, 60, or >60 days. The questions were developed to identify physiological and lifestyle changes that might be related to WFH behaviors. The physiological parameters included were body weight, height, waist circumference, hip circumference, and stress level. Qualitative assessments of behaviors and stress were made using numeric scores. The Perceived Stress Scale (PSS-10), an instrument for the assessment of the perception of stress that was originally developed by Dr. Sheldon Cohen[22], is used to assess stress, and we used the Thai version, which was used in a previous study[23] and demonstrates high levels of reliability (Cronbach's alpha 0.84) and validity. The test comprised 10 questions, and the participants evaluated each item on a five-point scale, between 0 (never) to 4 (very often). Therefore, the total PSS-10 score was between 0 and 40, with higher scores indicating higher perceived stress. Scores of 1–13 were considered to reflect mild stress, a score of 0 was considered to indicate no stress, a score of 14–26 was considered to reflect moderate stress, and a score of 27–40 was considered to reflect severe stress. We further classified participants who were rated as having no, mild, moderate, or severe stress according to a stress pyramid, based on the numbers of 0, 1, 2, and 3 scores. In addition, other obesity-related behaviors were assessed: the duration of the working day, the duration of exercise per week, the number of meals consumed per day, and the amounts of caffeine consumed per day.

Statistical analysis

Before further analysis, the Kolmogorov-Smirnov test was used to test the normality of each set of data. Data are expressed as mean ± SEM or n (%) for the characteristics of the participants and mean ± SEM for other parameters. Comparisons of two related groups were performed using the paired Student's *t*-test. Comparisons among the WFH groups were made using one-way analysis of variance (ANOVA) after checking for homogeneity of variance, followed by Fisher's least significant difference (LSD) test, as appropriate. For non-normally distributed data the Wilcoxon signed rank test was used to compare two groups. $P < 0.05$ was considered to represent statistical significance.

Results

Characteristics of the participants

The characteristics of the participants are shown in Table 1. The mean ± SEM age of the participants was 33.54 ± 0.95 and they were between 22 and 64 years of age. The 78 participants consisted of 20 men (26%) and 58 women (74%). The participants comprised 12 lecturers, 55 support staff, and 11 others (15%, 71%, and 14% of the total, respectively). The participants were placed into four groups according to the length of time that they were asked to work from home: a 15-day WFH group (n=36; 46%), a 30-day WFH group (n=11; 14%), a 60-day WFH group (n=20; 26%), and a >60-day WFH group (n=11; 14%). Fifty participants reported that they were single (64%) and 28 reported that they were married (36%). The participants' BMIs before WFH are shown in Table 2. Eleven (14%), 31 (40%), 13 (17%), and 23 (29%) of the participants were categorized as having underweight, normal weight, overweight, and obesity, respectively.

Table 1. Participant characteristics

	Mean ± SEM	N (%)	Range
Age	33.5 ± 1.0		22–64
Sex			
male		20 (26)	
female		58 (74)	
Position			
lecturer		12 (15)	
support staff		55 (71)	
other		11 (14)	
Duration of WFH			
15 days		36 (46)	
30 days		11 (14)	
60 days		20 (26)	
> 60 days		11 (14)	
Marital status			
single		50 (64)	
married		28 (36)	

Values are mean ± SEM for age and number (percentage) for the other parameters. N=78. WFH, working from home.

Table 2. BMI distribution of the participants before WFH

Category	BMI (kg/m^2)	N (%)
Underweight	< 18.5	11 (14)
Normal weight	18.5–22.9	31 (40)
Overweight	23.0–24.9	13 (17)
Obese	≥ 25	23 (29)

Participants were classified using the BMI convention for Asian individuals. Values are the numbers of participants (percentages). BMI, body mass index; WFH, working from home.

Relationships between the duration of WFH and obesity-related parameters

The relationships of WFH of various durations with obesity-related parameters (body weight, BMI, waist circumference, hip circumference, and waist/hip ratio (WHR) are shown in Table 3 and Figure 1. As shown in Figure 1A, the body weight of the 15-day WFH group significantly increased during the WFH period (61.3 ± 2.3 kg before WFH and 62.3 ± 2.4 kg after WFH, p < 0.05). The body mass of the 30-day WFH group tended to be higher after WFH (63.4 ± 4.5 kg before WFH and 65.3 ± 4.4 kg after WFH, p = 0.06). However, the body masses of the 60-day WFH and >60-day WFH groups did not change during WFH (62.2 ± 3.5 kg ***vs***. 62.9 ± 3.5 kg, p = 0.12 and 60.7 ± 5.9 kg ***vs***. 61.4 ± 5.9 kg, p = 0.34, respectively).

The BMIs of the participants before and after WFH are shown in Figure 1B. There was a significant increase in the BMI of the 15-day WFH group (22.86 ± 0.66 kg/m^2 before WFH and 23.21 ± 0.67 kg/m^2 after WFH, p < 0.05) and the 30-day WFH group (23.57 ± 1.01 kg/m^2 before WFH and 24.33 ± 1.05 kg/m^2 after WFH, p < 0.05). The 60-day WFH group showed a trend toward an increase in BMI (22.64 ± 1.14 kg/m^2 before WFH and 22.93 ± 1.14 kg/m^2 after WFH, p=0.09). However, there was no change in the BMI while WFH in the >60-day WFH group (27.15 ± 6.00 kg/m^2 before WFH and 27.45 ± 5.90 kg/m^2 after WFH, p = 0.34).

There were no changes in any of the WFH groups with respect to waist circumference (Figure 1C; 77.0 ± 1.6 cm ***vs***. 77.1 ± 1.7, p = 0.70 for the 15-day WFH group; 79.6 ± 4.1 cm ***vs***. 81.1 ± 3.8 cm, p = 0.19 for the 30-day WFH group; 76.0 ± 2.9 cm ***vs***. 77.0 ± 2.9 cm, p = 0.15 for the 60-day WFH group; and 76.0 ± 3.4 cm ***vs***. 77.6 ± 3.6 cm, p = 0.21 for the >60-day WFH group), hip circumference (Figure 1D; 91.8 ± 1.2 cm ***vs***. 92.1 ± 1.3 cm, p = 0.46 for the 15-day WFH group; 95.2 ± 2.7 cm ***vs***. 97.0 ± 2.6 cm, p = 0.15 for the 30-day WFH group; 95.7 ± 2.4 ***vs***. 96.8 ± 2.4 cm, p = 0.10 for the 60-day WFH group; and 89.4 ± 1.8 cm ***vs***. 90.4 ± 2.0 cm, p = 0.15 for the >60-day WFH group), or WHR (Figure 1E; 0.84 ± 0.01 ***vs***. 0.84 ± 0.01, p = 0.68 for the 15-day WFH group; 0.85 ± 0.04 ***vs***. 0.84 ± 0.03, p=0.54 for the30-day WFH group; 0.79 ± 0.02 ***vs***. 0.80 ± 0.02, p=0.52 for the 60-day WFH group; and 0.82 ± 0.04 ***vs***. 0.84 ± 0.11 p = 0.17 for the >60-day WFH group).

Table 3. Obesity-related parameters in participants classified according to the duration of WFH

Parameter	Duration of WFH (days)											
	15 days		*p* value	30 days		*p* value	60 days		*p* value	> 60 days		*p* value
	Before	After		Before	After		Before	After		Before	After	
Body weight (kg)	61.28 ± 2.28	62.28 ± 2.36	0.04*	63.36 ± 4.51	65.28 ± 4.40	0.06	62.17 ± 3.52	62.93 ± 3.51	0.12	60.65 ± 5.90	61.43 ± 5.92	0.34
BMI (kg/m^2)	22.86 ± 0.66	23.21 ± 0.67	0.04*	23.57 ± 1.01	24.33 ± 1.05	0.04*	22.64 ± 1.14	22.93 ± 1.14	0.09	27.15 ± 6.00	27.45 ± 5.90	0.34
Waist circumference (cm)	76.95 ± 1.63	77.13 ± 1.73	0.70	79.64 ± 4.10	81.05 ± 3.81	0.19	75.97 ± 2.85	76.98 ± 2.85	0.15	76.02 ± 3.41	77.60 ± 3.61	0.21
Hip circumference (cm)	91.78 ± 1.22	92.06 ± 1.30	0.46	95.15 ± 2.70	96.98 ± 2.60	0.15	95.71 ± 2.35	96.78 ± 2.44	0.10	89.36 ± 1.83	90.37 ± 1.99	0.15
WHR	0.84 ± 0.01	0.84 ± 0.01	0.68	0.85 ± 0.04	0.84 ± 0.03	0.54	0.79 ± 0.02	0.80 ± 0.02	0.52	0.82 ± 0.04	0.84 ± 0.11	0.17

Data are mean ± SEM. * p < 0.05 for the comparison between before and after WFH (paired Student's *t*-test). BMI, body mass index; WFH, working from home; WHR, waist/hip ratio.

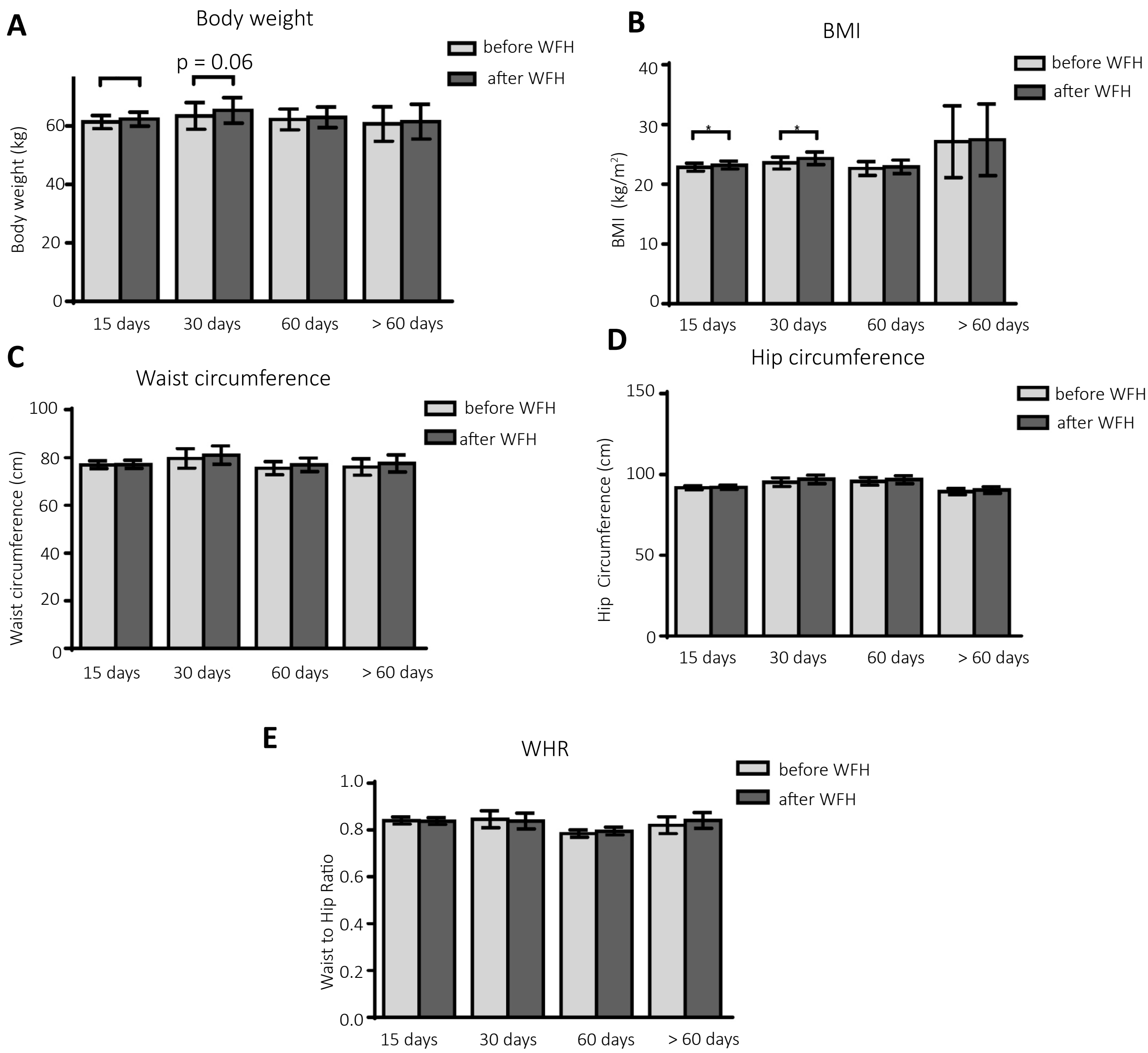

Figure 1. Relationships between WFH and obesity-related parameters in participants classified according to the duration of WFH. Body weight (A), BMI (B), waist circumference (C), hip circumference (D), and WHR (E) before and after WFH for the 15-day WFH, 30-day WFH, 60-day WFH, and >60-day WFH groups. Values are mean ± SEM. Comparisons of the before-and-after data were performed using the paired Student's *t*-test (**p* < 0.05), except for the BMI data for the 30-day WFH group, which were analyzed using the Wilcoxon signed rank test. Light bars: before WFH; dark bars: after WFH. BMI, body mass index; WFH, working from home; WHR, waist/hip ratio.

Relationships of the duration of WFH with obesity-related behaviors, physical activity, and stress level

We also analyzed the relationships of WFH of various durations with obesity-related behaviors (stress level, number of meals consumed per day, frequency of food deliveries, physical activity, and coffee consumption). The self-reported stress level for each group is shown in Table 4 and Figure 2A. We found significantly higher stress in the 30-day WFH group than in the 15-day WFH group (2.40 ± 0.22 *vs*. 1.86 ± 0.127, respectively, *p* < 0.05). Interestingly, the reported stress level of the 60-day WFH group was significantly lower in the 60-day WFH group (1.70 ± 0.13 *vs*. 2.40 ± 0.22; p < 0.01) and tended to be lower in the >60-day WFH group (1.91 ± 0.21 vs. 2.40 ± 0.22; *p* = 0.09) than in the 30-day WFH group.

No significant differences in the number of meals consumed per day were found among the groups (Figure 2B; 2.76 ± 0.08, 2.82 ± 0.12, 2.85 ± 0.08, and 2.73 ± 0.19 for the 15-day, 30-day, 60-day, and >60-day groups, respectively), but the number of times food was delivered per day was significantly lower in both the 60-day WFH (1.92 ± 0.29) and >60-day WFH (2.73 ± 0.19) groups than in the 30-day WFH group (2.82 ± 0.12, p<0.05; Figure 2C). The physical activity of the participants tended to be lower in the 30-day WFH group, but this difference was not significant (Figure 2D; 128.8 ±21.9 minutes/week, 76.4 ± 38.7 minutes/week, 146.7 ± 26.7 minutes/week, and 180.0 ± 3.7 minutes/week for the 15-day, 30-day, 60-day, and >60-day WFH groups, respectively). The amount of coffee intake also didnot significantly differ among the groups (Figure 2E; 2.22 ± 0.14, 2.70 ± 0.15, 2.65 ± 0.13, and 2.09 ± 0.28 cups per day for the 15-day, 30-day, 60-day, and >60-day WFH groups, respectively).

Table 4. Obesity-related behaviors, physical activity, and stress level of the participants, classified according to the duration of WFH

Parameter	Duration of WFH				*p* value
	15 days	30 days	60 days	> 60 days	
Stress level	1.86 ± 0.127	2.40 ± 0.22	1.70 ± 0.13	1.91 ± 0.21	<0.05
Number of meals consumed per day	2.76 ± 0.08	2.82 ± 0.12	2.85 ± 0.08	2.73 ± 0.19	0.86
Number of food deliveries per day	2.22 ± 0.21	3.00 ± 0.00	1.92 ± 0.29	1.86 ± 0.40	<0.05
Physical activity (minutes/week)	128.8 ± 21.9	76.4 ± 38.7	146.7 ± 26.7	180.0 ± 3.7	0.33
Coffee consumption (cups/day)	2.22 ± 0.14	2.70 ± 0.15	2.65 ± 0.13	2.09 ± 0.28	0.07

Data are the mean ± SEM. WFH, working from home.

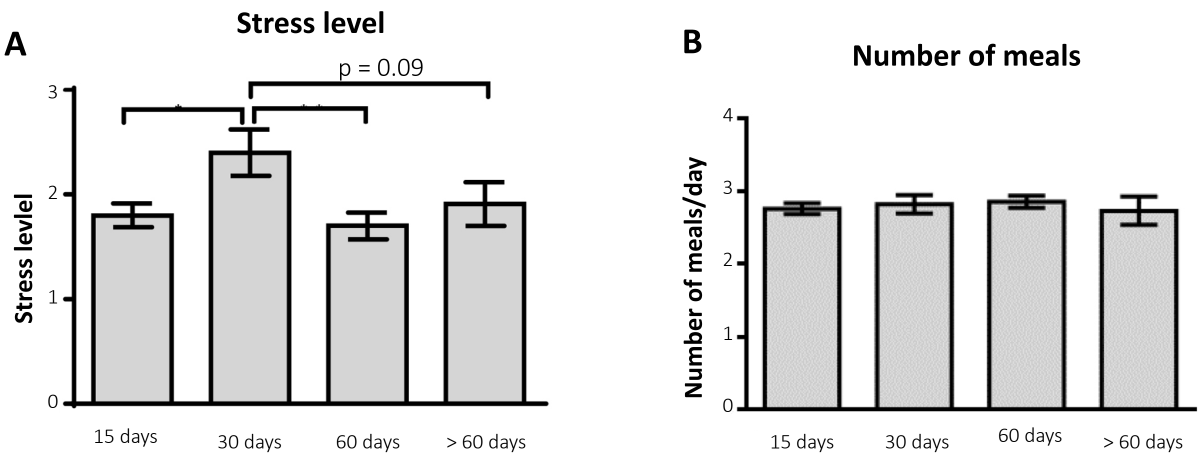

Figure 2. Relationships of the duration of WFH with obesity-related behaviors. Stress level (A), number of meals consumed per day (B), number of food deliveries per day (C), physical activity (D), and number of cups of coffee consumed per day (E) for the participants in each WFH group. Values are mean ± SEM. Data were compared among the groups using one-way analysis of variance (ANOVA), after checking for homogeneity of variance, followed by the LSD test, as appropriate. * p < 0.05.

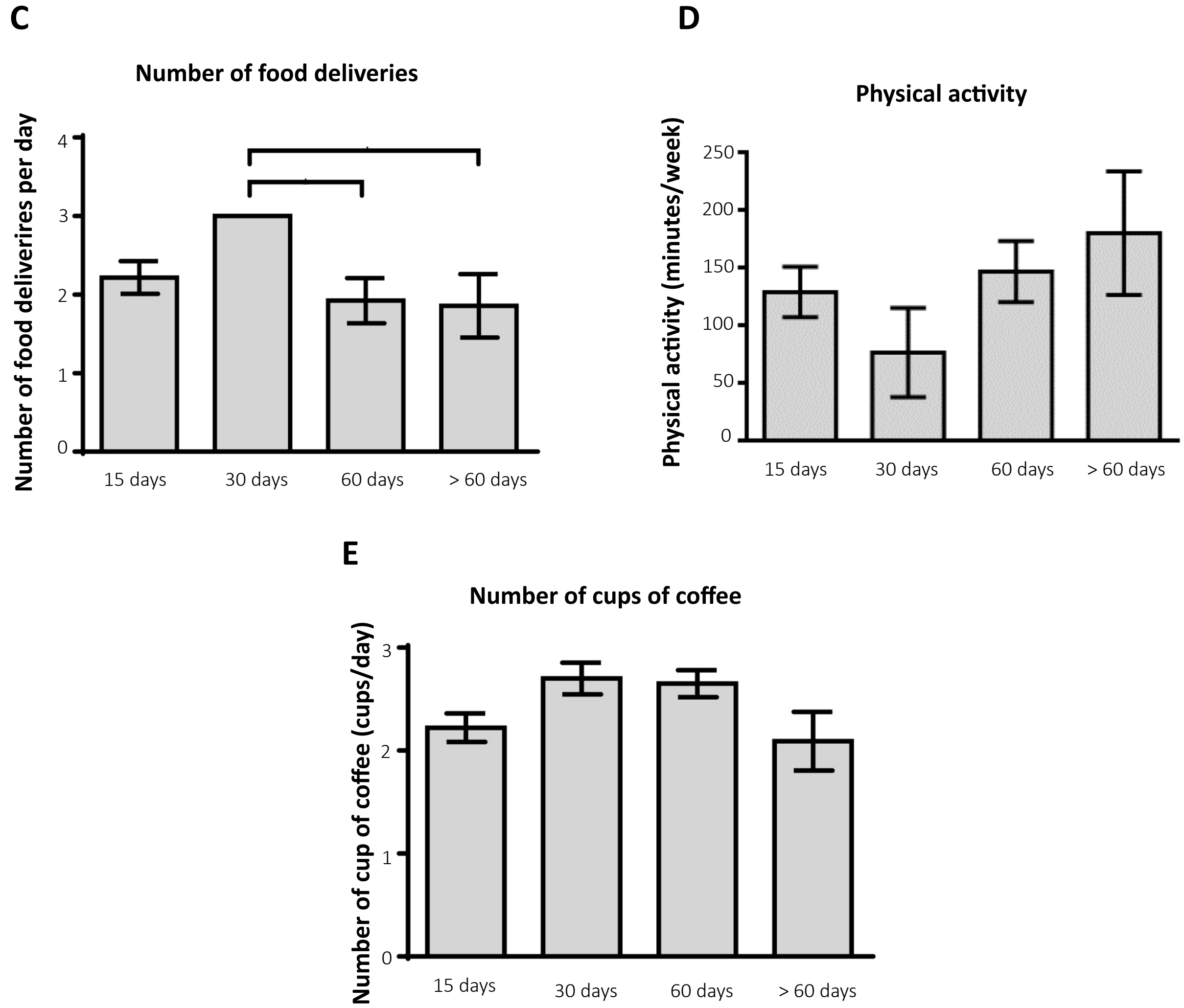

Figure 2. Relationships of the duration of WFH with obesity-related behaviors. Stress level (A), number of meals consumed per day (B), number of food deliveries per day (C), physical activity (D), and number of cups of coffee consumed per day (E) for the participants in each WFH group. Values are mean ± SEM. Data were compared among the groups using one-way analysis of variance (ANOVA), after checking for homogeneity of variance, followed by the LSD test, as appropriate. * $p < 0.05$. (Cont.)

Discussion

In the present study, we characterized the relationships of WFH of various durations with obesity and obesity-related behaviors in workers at an academic institution in Thailand during the lockdown associated with the first wave of the COVID-19 pandemic. The self-reported data show that the participants who worked from home for 15 days gained a mean of ~1 kg during the WFH period, which was associated with a mean increase in BMI of 0.35 kg/m^2. Similarly, participants who worked from home for 30 days showed a trend toward an increase in body weight and a significant mean increase in body mass of 0.76 kg/m^2. These data suggest that a short duration of WFH increased the adiposity of workers during the enforced lockdown. These results are consistent with those of previous studies showing that 1 month of quarantine was associated with increases in body mass and BMI in Italians with obesity[12] and Italian in-patients without a psychiatric diagnosis[18].

This weight gain is likely to be the result of a disruption in the balance between energy intake and energy expenditure[24]. Humans obtain their energy through the consumption of food and beverages and expend energy through resting metabolism, the thermic effect of food, physical activity, and non-exercise activity thermogenesis (NEAT)[24, 25]. In the present study, we found that the physical activity and number of meals consumed while WFH were comparable among the groups, but the frequency of food deliveries was highest for the participants who worked from home for 30 days. This implies that the eating behavior of the participants might have changed during the 30-day period of WFH, and that this might have been associated with an increase in the amount of food consumed, resulting in body mass gain. However, this finding differs from those of a previous study of Polish adults who underwent 1 month of social isolation, during which most of the participants (51.6%) did not order takeaway food. However, the number of meals consumed per day increased in those participants (31.1%) who typically consumed five or more meals per day[13]. This difference may be the result of cultural differences, the strength of the government measures, and the severity of the pandemic affecting people's decisions regarding food. During the first wave of COVID-19 in Thailand, which occurred between January and July 2020, the public health measures were not very severe because the number of confirmed COVID-19 cases was not very high[11]. This might have meant that the participants were confident enough to order food to consume without fear of infection.

The anthropometric data that reflect adiposity (waist circumference, hip circumference, and WHR) for the 15-day and 30-day WFH groups did not change during their WFH periods. This might be because the short duration of WFH was not sufficient to alter the degree of central obesity of the participants. For the 60-day and >60-day WFH groups, all the obesity-related data (body mass, BMI, waist circumference, hip circumference, and WHR) were comparable before and after the WFH periods. This suggests that a longer duration of WFH does not affect adiposity. However, the participants ranged in age from 22 to 64 years, and thus these findings might have been confounded by age-related differences in energy expenditure. Indeed, previous studies have shown that advancing age is associated with a decline in energy expenditure[26, 27].

We have also shown that the amount of coffee consumed each day is similar for individuals who work from home for differing lengths of time. However, a number of previous studies have shown that caffeine intake can protect against obesity. For example, caffeine was shown to increase fatty acid breakdown and fat oxidation[28], and the long-term consumption of more than two cups of coffee a day reduces the risk of developing metabolic syndrome[29]. The present findings suggest that the anthropometric differences among the various WFH groups are not the result of differences in coffee consumption. This may be because the participants in the present study consumed a mean of two-to-three cups a day, which was insufficient to observe effects of caffeine in previous studies[29, 30]. Although there may have been some changes in hormone concentrations, these might not have been sufficient to cause whole-body changes in adiposity. Alternatively, the participants who reported coffee consumption may have already been subject to the effect of caffeine to limit metabolic dysfunction, and the amount of caffeine consumed by the participants did not change during the periods of WFH. In future studies, this issue could be investigated in greater depth by strictly controlling the volumes of caffeinated drinks consumed and by considering a wider range of physiological variations. However, other types of beverages might have more effect on adiposity than coffee.

The stress level of the 30-day WFH group was the highest of the groups, which is consistent with the findings of previous studies that COVID-19-related lockdowns increased the stress levels of French[31] and Austrian[32] adults because of greater boredom, sadness, depression or anxiety. These results all suggest that the pandemic caused stress and anxiety, probably because of the fear of infection and death[31, 32]. However, after an acclimation period to WFH, which may be approximately 30 days in length, the stress level was lower. WFH may provide a sense of security because of the lower risk of infection, but other studies have shown that an extended period of WFH might increase stress in individuals in some cultures in which office-working is preferred[33, 34]. Thus, differences in culture or living conditions may affect stress management, despite similar levels of social isolation.

A previous study showed that stress was one of the factors that could be used to predict body mass gain in patients without a psychiatric diagnosis during the lockdown[18], probably because it is associated with greater adiposity under normal circumstances[35]. Many previous studies have shown correlations between stress level and body mass gain. Stress is frequently implicated in weight gain, abdominal fat accumulation, and obesity, and there are multiple explanations for this relationship. Behavioral changes such as binge eating, nocturnal food consumption, and the consumption of high-calorie meals can all lead to obesity[18]. Furthermore, the hormonal changes associated with stress, such as high cortisol concentration, can lead to an inflammatory response, metabolic dysfunction, and obesity. Stress can also be associated with glucocorticoid receptor dysfunction because this can cause increases in fat accumulation and weight gain[35]. The present self-reported data showed no significant behavioral changes during the WFH periods, which may be because the hormonal and cellular changes experienced were within the normal physiological ranges. In contrast, the higher stress level of the 30-day WFH group may be associated with the body mass gain that these individuals experienced.

Notably, the stress level of the >60-day WFH group was comparable to those of the 60-day and 15-day WFH groups. As mentioned above, the decrease in stress level following a WFH period of >30 days may be explained by acclimation to the situation[33, 34]. Similarly, we found that long durations of WFH (60 days and >60 days) were not associated with changes in adiposity, anthropometry, food intake behaviors, or physical activity. We hypothesize that the participants might have changed their behaviors that tend to result in increases in body mass and the risk of obesity. Such behavioral adaptations to the longer durations of WFH might account for the lack of any differences in those parameters. However, further research should be performed to determine the length of any acclimation period, which may depend on the specific trigger of the stress, the cultural context, and the population studied.

Conclusion

We have shown that short periods of WFH (15 or 30 days) that are mandated in workers are associated with increases in body weight and BMI. Obesity-related behaviors, including stress level and the frequency of food delivery, were most obviously affected in individuals who worked from home for 30 days in the present study. However, the present study had various limitations, including the data being self-reported and in part retrospective. This study design permitted the participants to report obesity-related data, such as body mass and waist circumference, without accurate measurement, but such data are subject to bias and low reliability. Furthermore, the sample size was small and the sample was limited to staff members in a single faculty. However, the present findings may provoke further larger studies. Furthermore, an analysis of the energy content of the food and beverages consumed, their lipid and carbohydrate content, and the consumption of alcoholic beverages would be worthwhile because these have substantial effects on bioenergetics and weight gain. In summary, consideration of the body mass, BMI, obesity-related behaviors, and mental health-related parameters can be used to assess both the physical and mental health of workers during periods of lockdown.

Author contributions

S.C. and A.C. conceived and designed the study. P.Y. distributed the questionnaire to the participants. S.C., J.B., and A.C. contributed to the writing of the manuscript. All the authors participated in revising the manuscript. All the authors have read and agreed to the published version of the manuscript.

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Conflicts of interest

The authors declare no conflicts of interest.

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