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RESEARCH LETTER

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Energy intake and weight during the COVID-19 lockdown were not altered in a sample of older adults with type 2 diabetes in England

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COVID-19 and subsequent lockdowns have caused a significant disruption to society. The effects were felt on an individual level as daily activities were severely restricted and habitual patterns were disrupted.[1] Governmental advice restricting people's freedom and enforced periods at home have raised public health concerns regarding well-being beyond the risk of COVID-19 infection.[2] These concerns focused on negative impacts to lifestyle, activity, and diet, which are modifiable risk factors for mental and physical health.[3,4]

The importance of managing excess weight in people living with type 2 diabetes (T2D) is highlighted by evidence linking obesity and dysglycaemia to poor clinical outcomes and mortality in severely ill COVID-19 patients treated in critical care and perioperative settings.[5,6]

It is unclear if lockdown affected diet intake and body weight, although anecdotal evidence suggests that energy intake (kcal/d),[7] and therefore body weight,[8] might have increased during periods of lockdown, when increased intake in the home was not mitigated by reduced intake away from home.[7,8] Chronic excess energy intake is linked to body weight gain, which is one of the main predictors of T2D and cardiovascular disease.[9,10] To investigate habitual dietary intake changes during COVID-19, we completed a time-limited, cross-sectional, follow-up study to the Rationale and design of a cross-sectional study to investigate and describe the chronotype of patients with type 2 diabetes and the effect on glycaemic control: the CODEC study (Clinical Trial Registry Number: NCT02973412).[11] Ethical approval for the CODEC study was obtained from the West Midlands – Black Country Research Ethics Committee (16/WM/0457). Details of the CODEC study design and cohort are reported elsewhere[11] and the inclusion/exclusion criteria are provided here as supporting information. In this COVID-19 sample, participants were asked to record their diet intake during the lockdown of May-June 2019. A standardized 4-day diet diary was used and participants were asked to log a minimum of 2 weekdays and 1 weekend day of diet intake. This included all food, fluid, and supplements (if any).

Nutritional analysis software, Nutritics (https://en-gb.nutritics.com/p/home), was then used to analyse the diet data. A complete macronutrient and micronutrient profile was generated for each individual meal per day per participant and collated into grouped diet data. Total energy intake was estimated in kcal/d while macronutrients (carbohydrate, protein, and fat) were estimated in g/d. Body weight was self-reported (kg).

Social deprivation was determined by assigning an index of multiple deprivation (IMD) to each participant's resident area (based on postcode). IMD scores are publically available continuous measures of compound social and material deprivation linked to health outcomes (including income, employment, education, living environment, and

health). The IMD score ranges from 1 (most deprived) to 32 844 (least deprived) and are accessible via the UK Government website at https://imd-by-postcode.opendatacommunities.org/imd/2019.

Total physical activity (reported in milligravity units [mg]) was derived from the GENEActiv accelerometer (ActivInsights Ltd, Cambridgeshire, UK), which participants wore 24 hours a day for 8 days on their non-dominant wrist at baseline and during lockdown. Monitors were initialized to record accelerations at 100 Hz.

R software version 1.3.959 (http://cran.r-project.org) was used for all statistical analyses. Paired sample *t* test and mean ± SD were used where data were normally distributed and basic t-test assumptions were satisfied. The Wilcoxon signed-rank test was utilized as a valid non-parametric alternative to the paired sample *t* test where data distribution were significantly skewed, with data presented as median with interquartile range (IQR).

One hundred and nineteen participants were included in the study (Table 1). In total, 826 (413 during lockdown) days of diet data were available (Table 2).

The paired sample t-test of total energy intake showed no significant change in energy intake during lockdown compared to the pre-lockdown period. Additionally, lockdown did not have a meaningful impact on the distribution of fat, protein, carbohydrate, or alcohol intake. The Wilcoxon signed-rank test showed a trend towards an increase in caffeine consumption (mg/d) during lockdown, but this change was small. Alcohol consumption (for those who consumed alcohol) did not differ.

TABLE 1 Participant demographics and medications use

	Baseline (July 2017-March 2020)	Lockdown (May-June 2020)
Demographics (n = 119)		
Age (y) (mean ± SD)	65 ± 8.3	66.3 ± 8.3
Sex (% female)	53 (44.5%)	
Ethnicity (%)	White European = 103 (86.6%)	
	Indian = 9 (7.6%)	
	Black Caribbean = 3 (2.5%)	
	White and Asian = 1 (0.8%)	
	Other White = 2 (1.7%)	
	Other Asian = 1 (0.8%)	
Index of multiple deprivation rank score (quintile) (n = 118)	1 (most deprived) = 10	
	2 = 16	
	3 = 29	
	4 = 36	
	5 (least deprived) = 27	
Number of glucose-lowering therapies	0 = 21	0 = 20
	1 = 48	1 = 46
	2 = 24	2 = 28
	3 = 21	3 = 19
	4 = 5	4 = 7
Received advice from medical or healthcare professional	-	24 (20.2%)
Self-isolating during restrictions	-	88 (74%)
Advised to shield	-	24 (20.2%)

There was no evidence of body weight change in 105 participants who completed a baseline weight (recorded in clinic) and a lockdown weight (self-assessed at home). The pattern of results remained the same when looking at sex-specific weight and energy changes. As previously reported,[1] overall physical activity was reduced (~800 steps per day), meaning that the impact of total physical activity on body weight change is probably negligible.

In this prospective study of older adults, we did not observe any chronotype alterations during lockdown.

There are a number of limitations to this study. The CODEC sample was representative of the English population, our lockdown population was opportunistically recruited, and participants were self-selected for inclusion, which may have introduced selection bias. Additionally, our sample was not powered to detect differences in energy intake or body weight and there was a gap of up to 3 years between baseline and lockdown measurements, during which participant behaviour may have changed.

We note that initiation of glucose-lowering therapies may have been a factor affecting body weight. In particular, newer agents, such as glucagon-like peptide-1 receptor agonists (GLP-1 RAs) and sodium-glucose co-transporter-2 (SGLT-2) inhibitors, have been shown to induce weight loss.[12,13] Four participants were on GLP-1 RAs and 13 participants were on SGTL-2 inhibitors at baseline. During lockdown, two participants informed the trial team that they had started on GLP-1 RAs, while one participant started on SGTL-2 inhibitors and another one stopped. We accept that these changes in glucose-lowering therapies may have impacted weight in these participants.

We relied on self-reported weight during the lockdown period, while standardized operating procedures and calibrated weighing scales were used to accurately assess body weight at baseline by a suitably trained healthcare professional. We cannot rule out errors in body weight self-report as a result of inaccurate home-scale measurements or recall bias.

We used diet diaries to assess intake and these should be interpreted with caution, as they rely on self-reported data. We sought to minimize bias by using a standardized diet diary that accounted for week and weekend days, thus adjusting for potential alterations in dietary patterns throughout the week.[14] Diet diaries were also accompanied by detailed reporting instructions and prompts to include frequently forgotten items such as snacks, liquids, and alcohol, and they also included image guides of portion sizes.

There was no further follow-up to assess eating behaviour or weight after cessation of lockdown measures. We do not know if the eating patterns and other behaviours developed in this cohort during lockdown were transient or sustained. Furthermore, the generalizability of our findings may be limited. Lockdowns were implemented differently at national and regional levels across the globe, with significant variations in restriction severity and duration linked to the

TABLE 2 Participant anthropometric variables and dietary intake

	Baseline (July 2017-March 2020)	Lockdown (May-June 2020)	Mean difference (95% CI)	*P* value for difference
Anthropometric variables (n = 105) (mean ± SD)				
Weight (kg)	89.6 ± 17.8	89.2 ± 18.7	(−1.5, 2.2)	.7
Body mass index (kg/m^2)	31.2 ± 5.5	31.1 ± 6	(−1.5, 1.6)	.94
Diet variables (n = 119) (mean ± SD)				
Total energy intake (kcal)	1678 ± 570.5	1711 ± 600	(−98.3,35.6)	.36
Carbohydrate (g/d)	180.5 ± 70.8	184.2 ± 73.6	(−12.3, 3.4)	.26
Carbohydrate (%)	46.2 ± 8.0	44.5 ± 16.4	-	
Fat (g/d)	66.4 ± 35.4	67.2 ± 33.6	(−4.9, 3.1)	.67
Fat (%)	34.9 ± 6.3	35.3 ± 13.9	-	
Protein (g/d)	76.6 ± 29.1	75.9 ± 31.4	(−2, 5.8)	.33
Protein (%)	18.9 ± 4.0	18.6 ± 7.3	-	
Alcohol (mg/d) (median with [IQR])	11.5 [31]	15 [31]	(−6.5, 2.8)	.43
Caffeine (mg/d) (median with [IQR])	153.1 [137]	165.3 [144]	(−2, 21.5)	.11
Overall physical activity (mg)	22.3 (21.3, 23.2)	20.6 (19.5, 21.7)	−1.7 (−2.4, −1.0)	**<.001***

*Note:** With $P < 0.05$ accepted as significant.

incidence of COVID-19. Our reported data refer to a cohort that had experienced restrictions for 12 consecutive weeks. Populations that experienced longer or more severe restrictions may have had different outcomes regarding weight and energy intake.

We did not investigate the effect of lockdown on glycaemic control. However, an Italian retrospective observational study reported no significant alterations to HbA1c level change between lockdown and matched control groups.[15] Furthermore, this study mirrors our findings regarding weight, with no statistically significant shifts in body mass index (BMI) attributable to lockdown being detected. Similarly, a Turkish retrospective observational study reported no significant changes to HbA1c levels or BMI.[16]

Indeed, while the majority of large-scale surveys and questionnaire studies appear to indicate that people perceived that their weight increased,[7,17] our study and similar reports could not replicate these findings. While food choices and diet quality may be impacted,[18] from our interpretation of the current evidence, the effect of lockdown on weight and energy intake is not significant in this population.

Despite concerns to the contrary, we observed no explicit changes in dietary composition, energy intake, and body weight as a result of COVID-19 lockdown in our population of older adults living with T2D and excess weight.

CONFLICT OF INTEREST

The authors declare no conflict of interest for this paper.

AUTHOR CONTRIBUTIONS

F.A. Data collection, Analysis, Writing manuscript, E.R. Conduct/data collection, Analysis, Writing manuscript, J.H. Design, Conduct/data collection, Analysis, Writing manuscript, N.C. Conduct/data collection, Writing manuscript, E.B. Design, Conduct/data collection, Writing manuscript, A.H. Design, Conduct/data collection, Writing Manuscript, K.K. Design, Conduct/data collection, Writing Manuscript, M. D. Design, Conduct/data collection, Writing manuscript.

PEER REVIEW

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

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