Effect of the COVID-19 pandemic on body weight in people at high risk of type 2 diabetes referred to the English NHS Diabetes Prevention Programme

The effect on body weight of people in England associated with stay-at-home policies introduced to control the spread of COVID-19 is not yet known.

In 2016, the National Health Service (NHS) in England established The Healthier You: NHS Diabetes Prevention Programme (NHS DPP) and about 2 years later, universal population coverage in England was achieved. The NHS DPP was developed to prevent or delay the onset of type 2 diabetes in identified adults with non-diabetic hyperglycaemia (HbA_{1c} 42–47 mmol/mol [6·0–6·4%] or fasting plasma glucose 5·5–6·9mmol/L), through structured lifestyle interventions. Programme rationale, justification, implementation, and early outcomes have been described previously.[1] More than 750 000 people have now been referred into the programme.

In March, 2020, in response to the COVID-19 pandemic, programme delivery switched from group-based face-to-face sessions to remote sessions via telephone, video conferencing, or specific digital interventions. Body weight measurements changed from independently recorded to self-reported measurements.

We compared body weight of participants at entry to the programme between April 1, 2020, and March 31, 2021, with participants' weights at entry over the preceding 3 years (between April 1, 2017, and March 31, 2020), to estimate the effect of the COVID-19 pandemic on the body weight of people with non-diabetic hyperglycaemia (appendix p 1).

The NHS DPP minimum dataset contains data on all patients with non-diabetic hyperglycaemia referred to the programme and was used to identify the recorded weight of people at programme entry accessing at least one intervention session between April 1, 2017, and March 31, 2021 (appendix p 1). The legal basis for the data collections, data flows, and service evaluations have been described previously.[1]

72 611 participants remotely accessed an initial intervention NHS DPP session between April 1, 2020, and March 31, 2021, and 217 181 participants attended an initial intervention session during the previous 3 years. Of those, 46 069 (63%) and 208 054 (96%) participants respectively had a valid body weight measurement recorded at programme entry. The proportion of missing weight data in 2020–21 was higher for Black, Mixed, other, and unknown ethnic groups, but otherwise proportions of missing data were broadly similar across participant characteristics (appendix p 2).

The mean BMI was 30·8 kg/m² (95% CI 30·8–30·9) and mean body weight was 86·8 kg (86·6–87·0) during 2020–21, compared with a mean BMI of 30·4 kg/m² (30·4–30·4) and mean body weight of 84·4 kg (84·3–84·5) over the previous 3 years; an unadjusted weight difference of 2·4 kg (2·2–2·6; p<0·0001; (table). This weight difference was substantially larger than any yearly increase in 2017–19 (appendix pp 2–3), and the higher baseline weights were apparent from the onset of the pandemic. Participants with baseline weight data in 2020–21 were younger than those in the previous 3 years, whereas other characteristics were broadly similar.

After adjusting for age, sex, ethnicity, and socioeconomic deprivation, the mean body weight of people entering the programme during the pandemic was 0·68 kg (95% CI 0·49–0·87; p<0·0001) greater than that of people entering the programme in the 3 prepandemic years (table). There were significant interactions between participant characteristics and the observed differences in weight between the two time periods. Higher weights were recorded during the pandemic for people who were younger, female, and in the two quintiles of greatest deprivation compared with those who were older, male, and in the quintiles of lesser deprivation respectively. Asian ethnicity was associated with a smaller difference in body weight than White ethnicity; there were no significant differences for the other ethnic groups compared with White ethnicity, though the participant numbers in some population subgroups were small.

There has been much speculation about the effect of the COVID-19 pandemic and the resulting lockdown restrictions on body weight, especially given the known association of COVID-19 severity with high BMI.[2] This large analysis of data from more than 46 000 people at high risk of type 2 diabetes in England over the past year, compared with more than 200 000 people in the preceding 3 years, provides new insights into differential effects of the COVID-19 pandemic on body weight across the population. Participants entering the NHS DPP in 2020–21 tended to be younger than those entering in preceding years, which we have previously shown when the programme is delivered digitally.[3] However, even after adjustment for this, body weights at entry recorded during the pandemic remained significantly greater than those recorded in the previous 3 years.

Among people who were younger than 65 years, female, and in the two quintiles of greatest deprivation, the increase in baseline weights between the two cohorts assessed before and after pandemic onset was more than twice as large as the difference in the total sample. This greater weight

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For more on the **NHS DPP** see https://www.england.nhs.uk/diabetes/diabetes-prevention/

See Online for appendix

	Participants entering the programme in 2017–20	Participants entering the programme in 2020–21	Mean baseline weight in 2017–20, kg	Mean baseline weight in 2020–21, kg	Unadjusted weight difference, kg	Adjusted weight difference, kg*	p value for adjusted weight difference
Age, years							
<40	7169 (3%)	3258 (7%)	91·4 (90·8–92·0)	95·3 (94·4–96·3)	3·9 (2·8 to 5·0)	3·00 (2·22 to 3·78)	<0·0001
40–64	84 641 (41%)	24 180 (52%)	88·6 (88·5–88·8)	90·6 (90·3–90·9)	1·9 (1·6 to 2·2)	1·67 (1·4 to 1·94)	<0·0001
65–74	73 703 (35%)	12 402 (27%)	82·9 (82·8–83·1)	82·6 (82·2–82·9)	–0·4 (–0·7 to 0·0)	–0·58 (–0·93 to –0·22)	0·0014
≥75	42 541 (20%)	6229 (14%)	77·2 (77·1–77·4)	76·2 (75·8–76·6)	–1·0 (–1·4 to –0·6)	–1·19 (–1·68 to –0·69)	<0·0001
Sex							
Female	114 142 (55%)	25 776 (56%)	79·0 (78·9–79·1)	82·7 (82·4–82·9)	3·7 (3·4 to 4·0)	1·54 (1·28 to 1·79)	<0·0001
Male	93 464 (45%)	20 253 (44%)	91·0 (90·9–91·1)	92·1 (91·8–92·4)	1·1 (0·8 to 1·4)	–0·40 (–0·69 to –0·12)	0·0058
Unknown	448 (<1%)	40 (<1%)	82·6 (81–84·3)	82·2 (75·3–89·1)	–0·4 (–6·3 to 5·4)	NA	NA
Ethnicity							
Asian	23 228 (11%)	5752 (12%)	76·2 (76·0–76·4)	77·9 (77·5–78·4)	1·7 (1·3 to 2·2)	–0·03 (–0·56 to 0·50)	0·91
Black	12 073 (6%)	3163 (7%)	87·0 (86·7–87·3)	89·2 (88·5–89·9)	2·2 (1·5 to 3·0)	0·62 (–0·10 to 1·34)	0·092
Mixed	3422 (2%)	883 (2%)	85·1 (84·5–85·8)	88·4 (86·8–90·0)	3·3 (1·7 to 4·9)	0·82 (–0·54 to 2·18)	0·24
Other	3071 (1%)	576 (1%)	80·6 (80·0–81·3)	82·0 (80·2–83·7)	1·3 (–0·4 to 3·0)	–0·65 (–2·28 to 0·99)	0·44
White	152 775 (73%)	34 232 (74%)	85·5 (85·4–85·6)	88·2 (87·9–88·4)	2·7 (2·4 to 2·9)	0·82 (0·60 to 1·04)	<0·0001
Unknown	13 485 (6%)	1463 (3%)	83·9 (83·5–84·2)	85·4 (84·3–86·5)	1·6 (0·5 to 2·6)	NA	NA
Deprivation quintile							
IMD 1 (most deprived)	34 899 (17%)	7615 (17%)	86·5 (86·2–86·7)	89·6 (89·0–90·1)	3·1 (2·6 to 3·6)	1·53 (1·07 to 2·00)	<0·0001
IMD 2	38 295 (18%)	8494 (18%)	85·1 (84·9–85·3)	88·4 (87·9–88·9)	3·2 (2·8 to 3·7)	1·45 (1·01 to 1·89)	<0·0001
IMD 3	41 715 (20%)	9494 (21%)	84·3 (84·1–84·5)	86·4 (85·9–86·8)	2·1 (1·6 to 2·5)	0·32 (–0·10 to 0·74)	0·13
IMD 4	44 176 (21%)	9997 (22%)	83·8 (83·6–84·0)	86·0 (85·6–86·5)	2·2 (1·8 to 2·7)	0·37 (–0·04 to 0·78)	0·074
IMD 5 (least deprived)	48 670 (23%)	10 428 (23%)	82·9 (82·8–83·1)	84·7 (84·3–85·1)	1·8 (1·4 to 2·2)	0·06 (–0·34 to 0·45)	0·77
Unknown	299 (<1%)	41 (<1%)	85·2 (83·0–87·5)	85·5 (77·9–93·1)	0·3 (–6·4 to 7·0)	NA	NA
Total	208 054 (100%)	46 069 (100%)	84·4 (84·3–84·5)	86·8 (86·6–87·0)	2·4 (2·2 to 2·6)	0·68 (0·49 to 0·87)†	<0·0001

Data are n (%), mean (95% CI), or p values. Adjusted mean difference was not calculated for unknown categories. NA=not applicable. IMD=Index of Multiple Deprivation. *Adjusted mean weight differences for a given characteristic were calculated using a multivariable linear regression model incorporating an interaction term between time period and the given characteristic. †This value relates to a regression model incorporating all characteristics.

Table: **Mean body weight at entry to the National Health Service Diabetes Prevention Programme during the COVID-19 pandemic and in the preceding 3 years**

increase is likely to have a significant effect on future type 2 diabetes incidence in these groups. After adjustment for initial BMI, the odds ratio of developing diabetes following a 1 kg longitudinal increase in body weight has been reported to be 1·08 (95% CI 1·04–1·13).[4] Future incidence might also be influenced by delays in presentation with type 2 diabetes because of health service disruption due to COVID-19, and a possible direct effect of SARS-CoV-2 on pancreatic β cell function.[5] In our companion Article,[6] we show an increase in hospital admissions coded with diabetic ketoacidosis during the pandemic in England in people with newly diagnosed diabetes; the underlying aetiology is unclear, although weight gain during home confinement might have been contributory.

This study has some substantial limitations. These data are not longitudinal, and we assessed different cohorts before and after pandemic onset. The reliance on self-reported weights in 2020–21 might have led to an underestimation of the true difference, as there is a tendency to under-report weight with self-reported measurements.[7] In addition, there were substantial missing weight data in 2020–21, which might have had an effect on the estimation of weight difference (appendix p 2). Given that the missing weight data were unlikely to be missing at random and that the distribution of missing weight values was not known, it was not possible to determine the effect of this missing data.

Two longitudinal studies in the USA have reported broadly similar effects on body weight before and after lockdown. In the first study, a convenience sample of 727 adults from across the country self-reported body weight during peak lockdown and 5 months later. There was a mean increase in weight of 0·62 kg; around 40% of participants reported gaining weight, and 18% reported losing weight.[8] In the second, much larger study, of 11 534 attendees at a medical facility in Massachusetts who had body weight recorded before and after lockdown (on average 3 months later), there was an increase in weight among women (0·51 kg [95% CI 0·31 to 0·72]), but a decrease among men (–0·81 kg [–1·14 to –0·46]), with the highest risk of weight gain among people younger than 40 years.[9] A systematic scoping review assessing the effect of COVID-19 on body weight and weight-related behaviours included 19 studies all using online self-report surveys and found that almost half of respondents reported that they had gained weight during the pandemic.[10]

The stay-at-home policies in England as a result of the COVID-19 pandemic have coincided with a small but clinically significant increase in mean body weight in people at high risk of type 2 diabetes, and differences were greater among women, younger people, and those from more deprived areas. This increase in body weight is likely to lead to an increase in the incidence of type 2 diabetes, and highlights the importance of ongoing access to the NHS DPP in England.

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