



Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

Elsevier hereby grants permission to make all its COVID-19-related research that is available on the COVID-19 resource centre - including this research content - immediately available in PubMed Central and other publicly funded repositories, such as the WHO COVID database with rights for unrestricted research re-use and analyses in any form or by any means with acknowledgement of the original source. These permissions are granted for free by Elsevier for as long as the COVID-19 resource centre remains active.



## Editorial

## Quasi-experimental study designs can inform pandemic effects on nutrition and weight gain in pregnancy

Stephanie A. Leonard<sup>\*</sup>, Danielle M. Panelli

Division of Maternal-Fetal Medicine and Obstetrics, Department of Obstetrics and Gynecology, Stanford School of Medicine, Stanford, CA, USA

The coronavirus disease 2019 (COVID-19) pandemic dramatically changed eating behaviors and physical activity, particularly in the spring and summer of 2020 when international lockdowns were enforced, and many people only left their homes for essential activities. Further, many communities experienced long lines and empty shelves at grocery stores due to panic buying, hoarding, supplier shortages, and social distancing policies. The first year of the pandemic also caused an estimated 25% increase in the global prevalence of anxiety and depression, with the greatest increase among young women [1]. More time at home, increased anxiety and depression, and reduced access to healthy food are widely believed to have caused weight gain among many Americans. In mainstream and social media, this pandemic-related weight gain was termed “quarantine 15” or “COVID 15” (referring to the number of pounds people supposedly gained). However, scientific evidence on whether and how the pandemic affected weight and weight-related behaviors among adults in the United States has been limited. Highly selective study samples, study designs that overlook temporal trends, and reliance on retrospective self-reported data—particularly for a stigmatized variable such as weight—have precluded definitive findings. Recent national survey data suggest variability in how weight among US adults changed in response to the pandemic, with an overall modest increase in average body mass index (0.6%) [2]. It has remained unknown how the pandemic may have affected weight among pregnant people, for whom excessive or inadequate weight gain are of concern for the pregnant person and infant [3].

Prior to the pandemic, approximately 48% of people with full-term singleton pregnancies gained more weight than recommended, and 21% gained less weight than recommended by the Institute of Medicine [3, 4]. Both excessive and inadequate weight gain during pregnancy can contribute to adverse outcomes, such as increased rates of gestational diabetes, hypertensive disorders of pregnancy, cesarean birth, and small- or large-for-gestational-age infants [3]. In this issue of the

*American Journal of Clinical Nutrition*, Nethery et al. [5] presented convincing evidence from Washington State that the early phase of the pandemic (March to December, 2020) caused a modest but significant increase in pregnancy weight gain. No effect on infant birth weight was observed, underscoring the small increase in pregnancy weight gain (mean weight gain increased from 12.1 kg to 12.4 kg).

The findings of this study are reassuring for the population at large and may reflect both the negative (e.g., increased anxiety) [1] and positive (e.g., increased sleep hours) [2] effects of the early pandemic period on diet and physical activity. However, in secondary analyses, the investigators found an almost three-fold increase in pregnancy weight gain among people >90<sup>th</sup> percentile for weight gain. That is, the obesogenic effects of the pandemic may have been largest among pregnant people who were already gaining weight at a high trajectory. These findings are concerning given that extremely high weight gain, particularly among people with a high prepregnancy body mass index, may confer the greatest risk in adverse outcomes, such as preterm birth, severe maternal morbidity, and obesity in later life [3, 6]. We believe that this population deserves further attention to understand how the pandemic may have caused increased weight gain and how such pathways could be mitigated.

A distinguishing strength of the report by Nethery et al. [5] is the thoughtful use of quasi-experimental methods. Other researchers interested in the effect of the pandemic or other population-level shocks on nutrition and weight may benefit from reading this paper as an example and considering such methods in their research. As described by the authors, interrupted time series analysis is a powerful quasi-experimental method that uses segmented regression to estimate how a shock (e.g., an event or an intervention) “interrupted” an underlying trend in an outcome [7]. A major advantage of this approach over traditional regression-based analyses is that it establishes underlying trends. As noted in this report, average pregnancy weight gain (absolute and z-score) decreased before the pandemic started [5]. Furthermore, there was a seasonal effect on pregnancy weight gain,

DOI of original article: <https://doi.org/10.1016/j.ajcnut.2022.09.001>.

Abbreviations: COVID-19, coronavirus disease 2019.

See corresponding article on page 364

<sup>\*</sup> Corresponding author.E-mail address: [stephanie.leonard@stanford.edu](mailto:stephanie.leonard@stanford.edu) (S.A. Leonard).<https://doi.org/10.1016/j.ajcnut.2022.09.004>

Received 28 September 2022; Accepted 29 September 2022;

0002-9165/© 2022 American Society for Nutrition. Published by Elsevier Inc. All rights reserved.

which was accounted for in their interrupted time series models but is often overlooked in impact evaluations. Researchers interested in studying pandemic effects may also consider the difference-in-differences method [8]. In this quasi-experimental design, both the difference in an outcome between groups and the difference in an outcome between time periods are used to estimate the impact of a shock. Similar to interrupted time series, this approach accounts for underlying trends in the outcome that is independent of the shock. A key assumption of the difference-in-differences method is that underlying trends in the outcome are the same in the study groups being compared.

Researchers should bear in mind other strengths and limitations of the report by Nethery et al. [5]. We believe that it is a strength that the study was conducted among one-third of all births in a state that adhered to national recommendations for restrictions to reduce the spread of COVID-19 during the initial phases of the pandemic. Additionally, the study population had an overall prepregnancy obesity prevalence (27%) similar to the average prevalence of prepregnancy obesity in the United States (29%) [9]. A notable limitation of the study is that it focused on the first 9 months following widespread lockdowns. Therefore, most people included in the study were already pregnant when lockdowns began and differed in their time exposed to the pandemic while pregnant. Furthermore, the implications of these findings for the impact of less restrictive pandemic policies starting in 2021 remain unknown.

Overall, the report by Nethery et al. [5] is informative about the effects of the first 9 months of the pandemic on pregnancy weight gain and infant birth weight, which were previously unknown. The study also serves as an example of how to conduct research about pandemic effects on nutrition and weight using quasi-experimental approaches. Going forward, we hope this study spurs additional research that examines the ongoing effects of the pandemic on diet, physical activity, and weight gain during pregnancy and ways that pregnant people can be supported in achieving their weight gain goals.

## Funding

DMP is supported by the Eunice Kennedy Shriver National Institute of Child Health and Human Development of the National Institutes of Health (1K12HD103084).

## Conflict of interest

The authors report no conflicts of interest.

## References

- [1] World Health Organization, Mental Health and COVID-19: Early evidence of the pandemic's impact, Scientific brief, 2 March 2022. [Internet]. (2022) Available from [https://www.who.int/publications-detail-redirect/WHO-2019-nCoV-Sci\\_Brief-Mental\\_health-2022.1](https://www.who.int/publications-detail-redirect/WHO-2019-nCoV-Sci_Brief-Mental_health-2022.1). Accessed date: September 28, 2022
- [2] B.J. Restrepo, Obesity prevalence among U.S. adults during the COVID-19 pandemic, *Am J Prev Med* 63 (2022) 102–106.
- [3] Institute of Medicine, *Weight gain during pregnancy: reexamining the guidelines*, National Academies Press, Washington, DC, 2009.
- [4] QuickStats: Gestational weight gain among women with full-term, singleton births, compared with recommendations — 48 states and the District of Columbia, 2015, *MMWR Morb Mortal Wkly Rep* 65 (40) (2016) 1121.
- [5] E. Nethery, J.A. Hutcheon, A. Kotaska, M.R. Law, P. Janssen, Weight gain in pregnancy and infant birthweight after the onset of the COVID-19 pandemic: an interrupted time series analysis, *Am J Clin Nutr* 117 (2023) 364–372.
- [6] S.A. Leonard, B. Abrams, E.K. Main, D.J. Lyell, S.L. Carmichael, Weight gain during pregnancy and the risk of severe maternal morbidity by prepregnancy BMI, *Am J Clin Nutr* 111 (2020) 845–853.
- [7] J.L. Bernal, S. Cummins, A. Gasparrini, Interrupted time series regression for the evaluation of public health interventions: a tutorial, *Int J Epidemiol* 46 (2017) 348–355.
- [8] C.R. Berry, A. Fowler, T. Glazer, S. Handel-Meyer, A. MacMillen, Evaluating the effects of shelter-in-place policies during the COVID-19 pandemic, *Proc Natl Acad Sci U S A* 118 (2021), e2019706118.
- [9] A.K. Driscoll, E.C.W. Gregory, Increases in prepregnancy obesity: United States, 2016–2019, *NCHS Data Brief* 392 (2020) 1–8.