

# Is substance use changing because of the COVID-19 pandemic? Conceptual and methodological considerations to delineating the impact of the COVID-19 pandemic on substance use and disorder

*Because many forms of substance use are in the midst of ongoing, long-term period fluctuations, traditional age-period cohort and other time-series models need to be expanded to consider and differentiate any period effect specific to the COVID-19 pandemic from any ongoing period effect that preceded the COVID-19 pandemic. Provided that the available data and analytical techniques for differentiating these period effects are used to their full potential, the field is already well positioned to assess the impact of the pandemic, and ultimately provide the best public health and clinical conclusions to patients, stakeholders and the public.*

Social isolation and loneliness due to quarantine and stay-at-home orders, bereavement and financial and employment distress all suggest that substance use and abuse may be collaterally affected by COVID-19. This has led to the growth of rapidly fielded and analyzed studies that purport to examine whether substance use has changed during the pandemic. We suggest that examinations of time-series illustrating substance use before, during and, ultimately, after the pandemic are the wrong foci of inquiry or, at least, too myopic to generate critically important public health insights about COVID-19 effects in the years and decades to follow 2020. Indeed, COVID-19 'effects' will loom large as we interpret any data series for years, and possibly decades, thus engaging conceptually and methodologically with how we ask and answer these questions requires serious inquiry.

Throughout we use the example of alcohol use as an outcome of interest, although the principles that we articulate are generalizable to other substances. For our purposes here, we assume the COVID-19 pandemic led to change in alcohol use in the population, although we are agnostic as to the direction of that change. We might initially conceptualize the change in alcohol consumption as a period effect: a relatively sudden and time-limited change across the population. Indeed, within a basic time-series analysis we might anticipate a change in population consumption patterns beginning in much of the world around February/March 2020, which we may logically attribute to the pandemic.

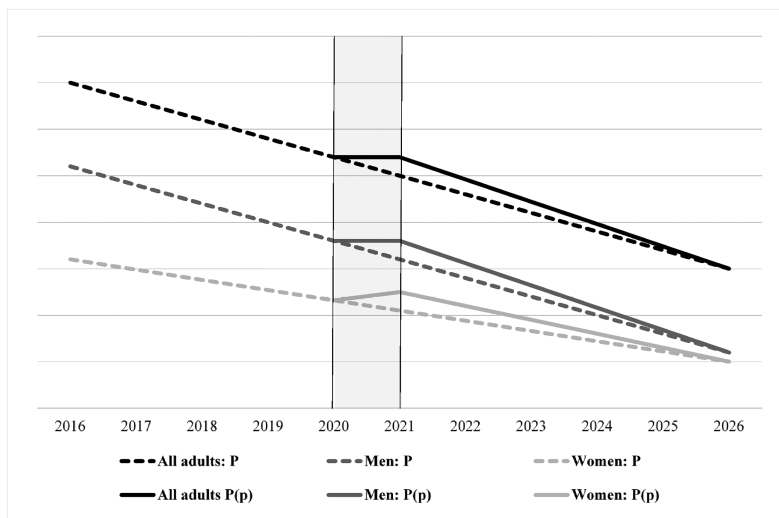
However, such an analysis may lead to incorrect inferences of the pandemic period effect. This is because any potential pandemic period effect is embedded within a

series of other historically dynamic processes. For example, during the last decade adult alcohol consumption has decreased in the European Union [1] and increased in the United States [2], with gender differences narrowing in both regions. Thus, based on these ongoing period effects alone, within both regions alcohol consumption should be different after the pandemic than before and to varying degrees across gender. As a result, capturing COVID-19 period effects requires more than simply assessing whether alcohol consumption immediately prior to the pandemic differs from consumption immediately after the pandemic. Instead, it requires disentangling any localized period effect specific to the pandemic (hereafter referred to as  $p$ ) from any ongoing, generalized period effect (hereafter referred to as  $P$ ) that preceded the pandemic. Here we conceptualize these as nested period effects, with  $p$  nested within  $P$  [ $P(p)$ ].

To illustrate, Fig. 1 depicts a hypothetical time trend for all adults with a decreasing  $P$ , as has been found for the European Union [1], and a decreasing  $P(p)$ . Within Fig. 1,  $p$  is equal to the distance between  $P$  and  $P(p)$ . The portion of Fig. 1 shaded in gray represents a hypothetical duration of the pandemic. Although hypothetical, during the course of the pandemic the  $P(p)$  trajectory deviates upwards from the  $P$  trajectory, indicating that the COVID-19 pandemic has resulted in increased alcohol use, as predicted by some [3,4]. Crucially, because the segment of the hypothetical  $P(p)$  trajectory that falls within the shaded portion of Fig. 1 is flat, a simple time-series analysis that compares alcohol consumption before and after the COVID-19 pandemic would falsely indicate that alcohol consumption did not change as a result of the pandemic.

Assessing whether COVID-19 effects persist after the end of the pandemic also demands differentiating  $p$  from  $P(p)$ . As hypothetically depicted for all adults in Fig. 1, following the pandemic the impact of COVID-19 dissipates over time and ultimately disappears by 2026, when  $P$  and  $P(p)$  are equal, indicating that  $p$  is equal to zero. However, a post-pandemic time-series analysis would not only overestimate  $p$ , it also would fail to capture that  $p$  diminishes and disappears over time.

In addition to the complexities of examining nested period effects [ $P(p)$ ], we also need to consider that the assessment of any purported COVID-19 period effect in alcohol may be complicated by interactions with demographic factors, such as gender. As illustrated in Fig. 1,



**Figure 1** Illustration of potential nested period effects and their interaction with gender

and consistent with known gender differences in ongoing period effects,  $P$  decreases for both genders but decreases faster for males. In Fig. 1, the localized period effect does not differ by gender (i.e. the upward deviation of  $p$  during the pandemic is the same for men and women). However, a simple time-series analysis that compares alcohol consumption before and after the COVID-19 pandemic would falsely indicate that  $p$  was flat for males but positive for females. Importantly, interactions may involve either level of the nested period effects. That is, just as ongoing period effects have varied by gender, potentially localized period effects also vary by gender. These nested period effects could also vary by cohort. Ongoing period effects in alcohol use are known to vary by cohort [2], and potentially the impact of the pandemic varies among younger cohorts (e.g. reduced access among college students who move back home leads to decreased use) and older cohorts (e.g. increased emotional and financial stress among middle-aged adults leads to increased use).

In conclusion, evidence suggests that alcohol use [1,2] and other forms of substance use [5,6] are in the midst of ongoing, long-term period fluctuations. Consequently, research progress on understanding the causal contribution of COVID-19 (and more generally the causal contribution of any acute historical event, including policy changes) to trends in substance use and abuse requires more than basic assessments of time trends. Therefore, traditional age-period-cohort models need to be expanded to consider nested period effects and their interactions with ongoing demographic and cohort effects. Analytical approaches for teasing apart nested period effects are available (e.g. growth models [7], interrupted time-series analysis [8], difference-in-differences analysis [9]). Thus, available data and methods are not rate-limiting in the pursuit of this knowledge. Rather, what is needed is comprehensive understanding and assessment of historical data and the contribution of broad-ranging policies and

exposures on existing trends to assess the impact of the profound changes in daily living produced by the pandemic as we strive to provide the best public health and clinical conclusions to patients, stakeholders and the public.

#### Declaration of interests

None.

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#### Author contributions

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