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Not all home drinking is equal: A latent class analysis of drinking patterns and alcohol consumption levels following initial COVID-19 restrictions in Australia, New Zealand and the United Kingdom

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Abstract

Introduction: Initial COVID-19 restrictions forced changes in the contexts (e.g., with who and where) within which individuals consumed alcohol. We aimed to explore different profiles of drinking contexts during initial COVID-19 restrictions and their association with alcohol consumption.

Method: We used latent class analysis (LCA) to explore subgroups of drinking contexts among 4891 respondents of the Global Drug Survey from the United Kingdom, New Zealand and Australia who reported drinking alcohol in the month prior to data collection (3 May–21 June 2020). Ten binary LCA indicator variables were generated from a survey question about last month alcohol settings. Negative binomial regression was used to explore the association between the latent classes and respondents' total number of drinks consumed in the last 30 days (i.e., alcohol consumption).

Results: The LCA found six distinct classes of individuals who reported drinking in the following contexts: household (36.0%); alone (32.3%); alone and household (17.9%); gatherings and household (9.5%); party (3.2%); and everywhere (1.1%), with the last group associated with the highest probability of increased alcohol consumption during this time. Male respondents and those aged 35 or older were most likely to report increased alcohol consumption.

Discussion and Conclusions: Our findings suggest that drinking contexts, sex and age influenced alcohol consumption during the early stages of the COVID-19 pandemic. These findings highlight a need for improved policy targeting risky drinking in home settings. Further research should explore whether COVID-19-induced shifts in alcohol use persist as restrictions are lifted.

KEYWORDS
alcohol, COVID-19, latent class analysis

1 | INTRODUCTION

Following the implementation of lockdown restrictions after the COVID-19 pandemic was declared in March 2020, patterns of alcohol consumption shifted almost exclusively towards drinking at home [1–4]. While international studies have shown both increases and decreases in alcohol consumption associated with this shift [5], increases in the overall frequency and/or quantity of alcohol consumption among those drinking at home during the early months of COVID-19 restrictions has been reported in the USA [2, 6], the United Kingdom [7], Australia [8], Norway [9], Poland [10], Belgium [11] and Germany [12]. For example, an analysis of alcohol sales in the USA identified a 20% increase between March and September 2020 compared to the same period in 2019 [2].

A 2022 systematic review and meta-analysis of 128 cross-sectional and longitudinal studies investigating changes in alcohol use during the initial months of the COVID-19 pandemic by Acuff and colleagues [5] identified a number of factors associated with increased alcohol consumption during this time. These included individual factors (e.g., being female, a young-to-middle-aged adult or Black), mental health-related factors (e.g., depression, stress, anxiety) and contextual factors such as pandemic-related income loss (e.g., financial hardship or burden), unstable employment or being an essential worker [5]. Many of these contextual factors related to the setting of drinking at home; for example, many of those who worked remotely [10, 13], lived with children [3, 7, 13, 14] or lived with more people [11, 15, 16] were more likely to increase their overall alcohol consumption during this time. Our previous study of changes in alcohol use among respondents of the Global Drug Survey (GDS) COVID-19 Special Edition also found that these contextual factors related to drinking at home (e.g., living with children) were associated with increased alcohol use [17]. This is of concern: although drinking at licensed venues is often more likely to cause short-term harm (e.g., injuries to self or others, road traffic accidents), most long-term harm from alcohol (e.g., heart disease, cancer [18], psychiatric conditions [19]) is associated with domestic alcohol use, often due to an increased volume of alcohol consumed in home settings versus at licensed venues [1, 20–24]. Furthermore, with home drinking frequently implicated in intimate partner and family domestic violence incidents [2, 25, 26], the harms of home drinking are not isolated to the alcohol consumer.

While a significant body of research investigating changes in alcohol use during the COVID-19 pandemic has emerged [5], less is known about the social context of this alcohol use, such as whether increased alcohol consumption was more likely among those drinking alone, with household members or drinking online with friends using video teleconference platforms (e.g., Zoom). For example, two studies included in the review by Acuff et al. [5] found that drinking alone was a risk factor for increased alcohol consumption [27, 28], and we are aware of limited research exploring alcohol use while socialising with friends via video teleconference platforms [29–32]. Sex- and age-related patterns in home drinking during initial COVID-19 restrictions also remain unclear; the review by Acuff and colleagues found no consistent sex-related differences in pandemic-related changes in alcohol consumption [5], and studies with younger samples demonstrate either static or decreasing alcohol consumption [33–35], while many older adults reported drinking more often during the pandemic [36].

Understanding trends in home drinking is important to ensure that policies aiming to reduce harmful patterns of alcohol use are targeted and relevant, especially as many individuals may continue to drink at home to avoid public or large social gatherings due to ongoing risks of COVID-19 transmission. This study uses latent class analysis (LCA) to explore the different profiles of drinking context (e.g., with who and where) during the initial months of the COVID-19 pandemic, and the influence of context, sex, age and financial hardship on alcohol consumption. To our knowledge, this is the first study to investigate home drinking during COVID-19 using LCA, which provides a unique person-centred modality to capture the heterogeneity in home drinking patterns and impacts on overall alcohol use and related health outcomes.

2 | METHOD

2.1 | Sample and design

The GDS is an anonymous annual online cross-sectional survey of alcohol and other drug use. Participants are recruited through the survey's promotion via media partners and collaborating institutions worldwide (e.g., Vice, Mixmag, The Guardian, Fairfax Media), and global social platforms, such as Facebook and Twitter. Detailed information about the GDS's methods, including recruitment, is described by Barratt et al. [37]. The survey is open to anyone aged 16 years or above who has used at least one drug (including alcohol) in the past 12 months. During the initial wave of pandemic restrictions, GDS launched a Special Edition on COVID-19 as part of a global effort to better understand the impact of the COVID-19 pandemic on people's lives, with a focus on alcohol and other drugs, mental health and relationships. The GDS COVID-19 Edition ran for 7 weeks between 3 May and

21 June 2020 and received 59,969 valid responses. The data included in the current study represent a subset of GDS respondents from Australia ($n = 1219$; 24.9%), New Zealand ($n = 2097$; 42.9%) and the United Kingdom ($n = 1575$; 32.2%) who reported alcohol use in the past 30 days, as these three countries had sufficient numbers of respondents for analysis, and are relatively comparable as high-income, primarily English-speaking countries. All three countries were experiencing lockdowns or other similar restrictions preventing social gatherings throughout the data collection period [38–40]. The study has received ethical approval from Kings College London (PNM/14/15-18), The University of Queensland (2017001452/11671/001), and The University of New South Wales (HC17769).

2.2 | Measures

Country of residence, age, and gender were used as reported by GDS respondents. Household composition data were transformed into four categories: lives alone; with family members (including children); with partner; and with others (e.g., housemates). To account for any financial hardship or burden experienced during COVID-19 restrictions, the following question was asked of respondents: 'In the past month, how difficult has it been for you to pay for the very basics like food, housing, medical care and heating?'. Response options were 'Very difficult', 'Difficult', 'Somewhat difficult', and 'Not very difficult'.

Alcohol consumption was determined by multiplying the frequency of alcohol consumption ('in the last 30 days, on how many days did you drink alcohol?') with the number of standard drinks consumed ('in the last 30 days, how many standard drinks containing alcohol did you have on a typical day?'). As a standard drink has a different volume of (pure) alcohol in the UK (0.8 grams of alcohol) compared to Australia and New Zealand (10 grams of alcohol) we multiplied the number of standard drinks reported by the UK respondents by 0.8. In this manner, a standard drink for this report is considered to have 10 grams of alcohol and reflects the standard drink definition used in New Zealand and Australia.

To identify latent profiles of drinking context, we included 10 binary indicator variables. Respondents were asked in which of the following contexts they consumed alcohol in the last 30 days (with respondents asked to select all that apply): (i) alone at home with no contact with other people; (ii) alone at home with other people co-present (e.g., video or audio calls, chats, watch parties); (iii) with household members at home; (iv) with household members at home with other people co-present; (v) music festivals; (vi) nightclubs; (vii) house parties; (viii) smaller gatherings; (ix) underground parties or events; or (x) street or public spaces. Responses for each of the 10 contexts were dichotomised into 'true' or 'false' variables.

2.3 | Statistical analysis

We excluded data from 311 respondents from analyses due to low numbers; this includes 65 respondents who reported identifying as non-binary or different gender and 246 respondents who reported being aged above 65 years. LCA was performed to identify subgroups of drinking settings across respondents. LCA is a statistical approach that characterises the heterogeneity within populations by identifying unobserved (latent) classes within populations [41]. This person-centred technique assumes that class membership is explainable by mutually exclusive patterns of scores across categorical indicators (e.g., survey questions) [41]. Using the poLCA package [42] within the R statistical computing environment [43–45] we fitted increasing numbers of latent classes from a 1-class model to a 9-class model to identify the simplest model with adequate fit. The Bayesian information criterion (BIC) and the Akaike information criterion were used to select the best-fitting model, where lower scores indicate better fit. LCA models were trained on an initial dataset ($n = 5239$) without age and gender exclusions; these cases ($n = 348$) were not assigned a class in the final dataset for regression analysis. We further reported the log-likelihood, residual degrees of freedom, adjusted BIC, sample-size adjusted Akaike information criterion, the likelihood ratio and the average posterior probability. Subsequently, we reviewed classification diagnostics by calculating the relative entropy (a measure of how distinct classes are) and the smallest class count (n) and size (%) for each latent class model. Each individual in our dataset is assigned a class based on their responses. This was conducted using the 'poLCA' package in R, which uses the Expectation–Maximisation algorithm to estimate the parameters of the latent class model and assigns individuals to classes based on their maximum posterior probabilities of belonging to each class.

To explore associations between drinking settings and alcohol consumption, we performed negative binomial regression on the latent classes identified. Three models were fitted with increasing number of variables and interactions. Model 1 evaluates the associations between the latent classes and alcohol consumption; model 2 incorporates the effects of sex, age and financial burden. For the interested reader, Table S1, Supporting Information,

TABLE 1 Sociodemographic characteristics of home drinking contexts by latent class membership and in the overall cohort.

	Alone ($N = 1578$)	Everywhere ($N = 53$)	Household ($N = 1759$)	Party ($N = 157$)	Household and gathering ($N = 467$)	Alone and household ($N = 877$)	Overall ($N = 4891$)
Age							
Mean (SD)	37.3 (12.9)	30.0 (9.87)	39.5 (13.3)	26.8 (9.17)	32.1 (13.1)	33.2 (10.1)	36.4 (12.9)
Median [Min, Max]	36.0 [16.0, 65.0]	29.0 [16.0, 63.0]	39.0 [16.0, 65.0]	24.0 [16.0, 57.0]	29.0 [16.0, 65.0]	31.0 [16.0, 65.0]	35.0 [16.0, 65.0]
Gender							
Male	849 (53.8%)	32 (60.4%)	800 (45.5%)	94 (59.9%)	220 (47.1%)	478 (54.5%)	2473 (50.6%)
Female	729 (46.2%)	21 (39.6%)	959 (54.5%)	63 (40.1%)	247 (52.9%)	399 (45.5%)	2418 (49.4%)
Country							
Australia	385 (24.4%)	26 (49.1%)	289 (16.4%)	83 (52.9%)	208 (44.5%)	228 (26.0%)	1219 (24.9%)
New Zealand	652 (41.3%)	14 (26.4%)	953 (54.2%)	29 (18.5%)	173 (37.0%)	276 (31.5%)	2097 (42.9%)
United Kingdom	541 (34.3%)	13 (24.5%)	517 (29.4%)	45 (28.7%)	86 (18.4%)	373 (42.5%)	1575 (32.2%)
Living situation[a]							
Alone	17 (1.1%)	3 (5.7%)	22 (1.3%)	5 (3.2%)	14 (3.0%)	13 (1.5%)	74 (1.5%)
Partner	199 (12.6%)	6 (11.3%)	599 (34.1%)	26 (16.6%)	84 (18.0%)	289 (33.0%)	1203 (24.6%)
Family	628 (39.8%)	26 (49.1%)	920 (52.3%)	81 (51.6%)	255 (54.6%)	389 (44.4%)	2299 (47.0%)
Other	197 (12.5%)	14 (26.4%)	218 (12.4%)	37 (23.6%)	75 (16.1%)	186 (21.2%)	727 (14.9%)
Missing	537 (34.0%)	4 (7.5%)	0 (0%)	8 (5.1%)	39 (8.4%)	0 (0%)	588 (12.0%)
Standard drinks in the last 30 days							
Mean (SD)	64.8 (68.2)	79.8 (72.3)	45.7 (53.0)	44.6 (50.8)	40.5 (51.5)	70.7 (60.3)	56.2 (60.7)
Median [Min, Max]	38.0 [2.00, 300]	63.0 [2.00, 300]	28.0 [2.00, 300]	30.0 [2.00, 300]	20.0 [2.00, 300]	53.0 [2.00, 300]	33.0 [2.00, 300]
How difficult is to pay for the very basics?							
Not very difficult	1246 (79.0%)	38 (71.7%)	1488 (84.6%)	108 (68.8%)	347 (74.3%)	765 (87.2%)	3992 (81.6%)
Somewhat difficult	220 (13.9%)	8 (15.1%)	192 (10.9%)	31 (19.7%)	75 (16.1%)	78 (8.9%)	604 (12.3%)
Difficult	70 (4.4%)	3 (5.7%)	43 (2.4%)	8 (5.1%)	24 (5.1%)	23 (2.6%)	171 (3.5%)
Very difficult	35 (2.2%)	3 (5.7%)	25 (1.4%)	8 (5.1%)	17 (3.6%)	6 (0.7%)	94 (1.9%)
Missing	7 (0.4%)	1 (1.9%)	11 (0.6%)	2 (1.3%)	4 (0.9%)	5 (0.6%)	30 (0.6%)

[a]Living situations are defined as follows: Alone = lives without others; Partner = lives with partner only; Family = lives with at least one family members (e.g., sibling, child, parent); Other = lives only with friends, housemates or another non-defined person.

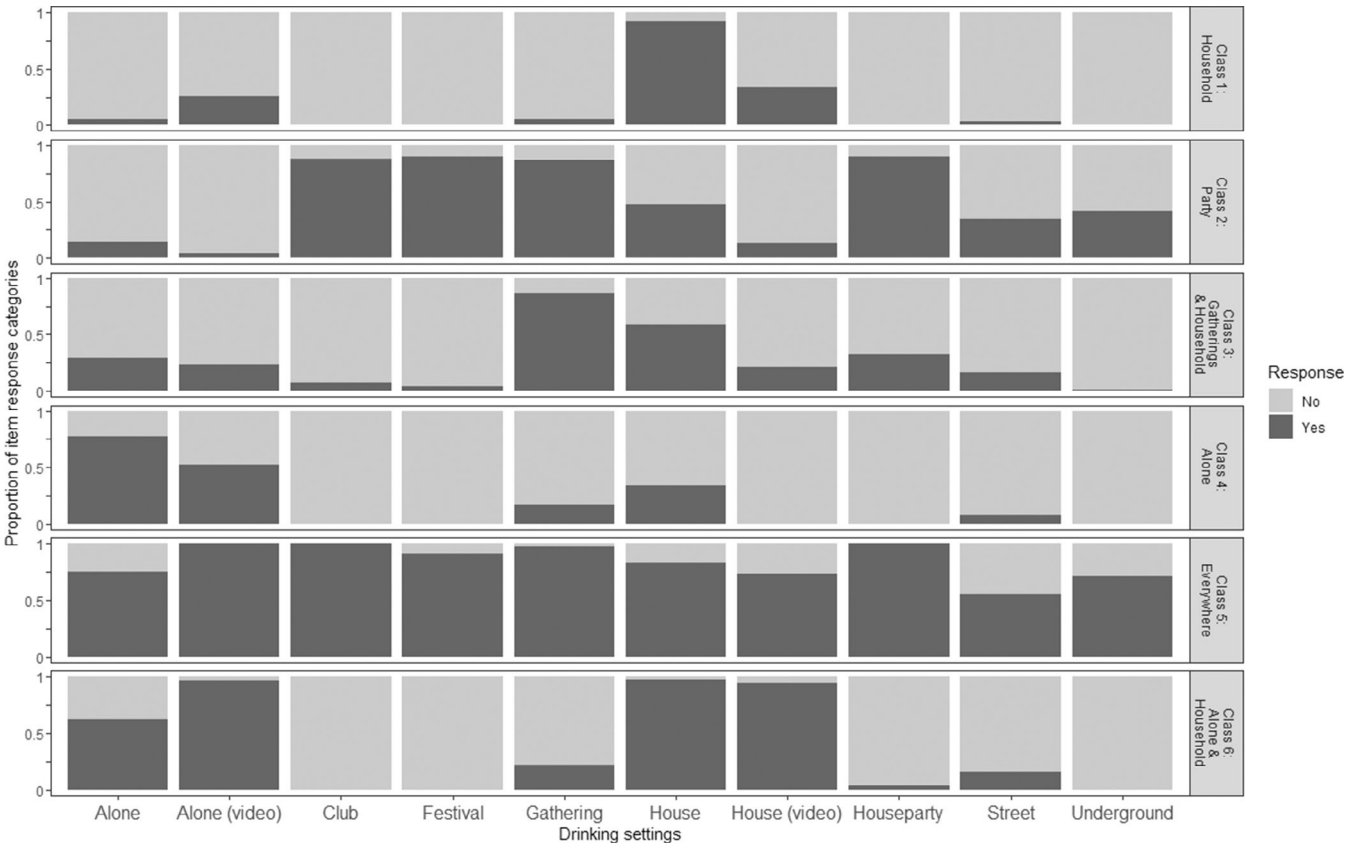

FIGURE 1 Endorsement profiles for past month alcohol use by latent class for the six-class model. Dark grey shows the probability of answering yes to the indicator variables. Light grey shows the probability of answering no to indicator indicators. Alone (video): alone with others co-present (e.g., video or audio calls, chats, watch parties); House (video): with household members and others co-present.

shows the influence of the interactions between latent classes and the three countries (with no additional covariates). All models were clustered to account for the influence of country on alcohol consumption using Stata [46]. The alone home drinking class was chosen as a reference for all models.

3 | RESULTS

3.1 | Sample characteristics

This study's sample comprised 4891 people from Australia, New Zealand and the United Kingdom who reported consuming alcohol in the past month. Table 1 summarises the sample's sociodemographic characteristics and Table S2, Supporting Information, shows the sociodemographic characteristics of respondents by country. The median age of the sample was 35.0 years (range 16–65 years) and 50.6% identified as male. Respondents were from New Zealand (42.8%), followed by the United Kingdom (32.2%) and Australia (25.0%), and most commonly lived with family members (47.0%), followed by a partner (24.6%), other people (14.9%; e.g., a housemate or friend) or alone (1.5%). The median number of standard drinks was 33 per month.

3.2 | Latent class analysis of drinking settings in the last 30 days

While fitting nine LCA models (from one to nine classes), the fit statistics generally continued to improve with increasing number of classes (see Table S3, Supporting Information). However, the BIC fit statistic suggested a 6-class model. This conservative statistic has been reported as the most prevalent fit statistic for LCA model selection [41], and has advantages in a performance evaluation context because our large sample size and easily distinguished classes (relative entropy = 0.875) [47]. Therefore, a six-class model was chosen considering the favourable BIC score and because a lower number of classes facilitate interpretability. Table S3 also reports the diagnostic statistics and Table S4 presents a matrix of average posterior probability across the 9 classes.

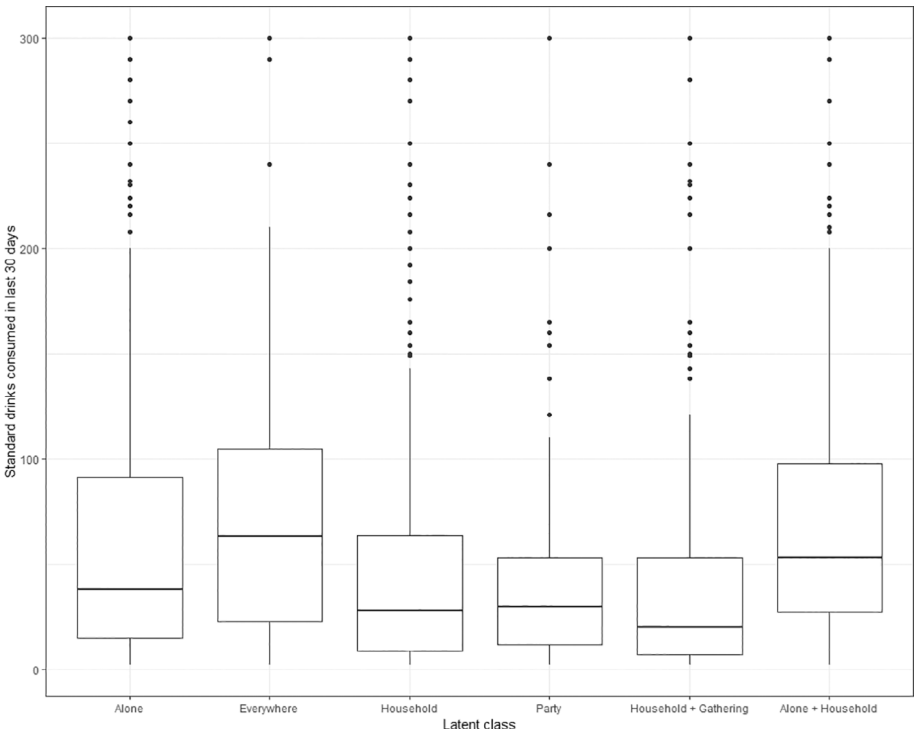

FIGURE 2 Box plot showing the median number of standard drinks consumed in the last month for each latent class. Black centre line of box denotes median alcohol consumption for each respective group; the box denotes the 25th to 75th percentile; black whiskers show 5th to 95th percentile; and individual dots denote outliers.

3.3 | Model interpretation

Figure 1 shows a graphical representation of the endorsement profiles in our six-class model. Here, the x-axis shows the indicator variables (drinking locations) and the y-axis shows the average probability of drinking in an indicator setting for each latent class. The endorsement probabilities suggest that latent classes can be labelled as follows:

1. *Household* (36.0% of the sample): very high probability of drinking with household members.
2. *Party* (3.2% of the sample): high probability of drinking at clubs, festivals, gatherings and house parties.
3. *Gatherings and household* (9.5% of the sample): very high probability of drinking at gatherings and high probability of drinking with household members.
4. *Alone* (32.3% of the sample): high probability of drinking alone and alone with others co-present (e.g., video or audio calls, chats, watch parties).
5. *Everywhere* (1.1% of the sample): high probability of drinking at all drinking settings.
6. *Alone and household* (17.9% of the sample): very high probability of drinking with household members, with household members at home with other people co-present (e.g., video calling), and alone with other people co-present. high probability of drinking alone.

In order of increasing alcohol consumption, the *Gatherings and household* class reported drinking the fewest median standard drinks in the past 30 days (median of 20 drinks), followed by *Household* (median of 28 drinks); *Party* (median of 30 drinks); *Alone* (median of 38 drinks), *Alone and household* (median of 53 drinks) and *Everywhere* (median of 63 drinks) classes. Figure 2 illustrates the differences in alcohol consumption between these latent classes.

3.4 | Association between latent class membership and alcohol consumption

Table S1 explores whether the six drinking type classification differ across the three country groups. The omnibus Wald test of the interaction between drinking type classifications and country was not significantly different ($Chi^2_{(10)} = 10.43; p = 0.4033$). With the absence of a significant interaction influencing drinking consumption between these two covariates, the following analysis ignores country as a covariate but clusters by country to account for any unobserved country-level effects (such as

TABLE 2 Associations between latent class analysis of drinking types and alcohol consumption.

	Model 1			Model 2		
Predictors	**IRR**	**95% CI**	***p***	**IRR**	**95% CI**	***p***
(Intercept)	64.84	55.3–76.04	<0.001	13.59	10.72–17.22	<0.001
Drinking type classification						
Alone	*Reference*			*Reference*		
Everywhere	1.23	1.07–1.41	0.003	1.35	1.10–1.65	0.004
Household	0.70	0.69–0.72	<0.001	0.71	0.68–0.75	<0.001
Party	0.69	0.59–0.80	<0.001	0.85	0.74–0.97	0.020
Household and gathering	0.62	0.55–0.72	<0.001	0.71	0.61–0.81	<0.001
Alone and household	1.09	0.99–1.20	0.083	1.20	1.09–1.31	<0.001
Age						
Age				1.07	1.06–1.09	<0.001
Age^2				1.00	1.00–1.00	<0.001
Gender						
Male				*Reference*		
Female				0.73	0.64–0.82	<0.001
Financial difficulty/hardship						
Not very difficult				*Reference*		
Somewhat difficult				1.24	1.19–1.29	<0.001
Difficult				1.31	1.25–1.37	<0.001
Very difficult				1.89	1.58–2.28	<0.001
Observations	4891			4861		
R^2 Nagelkerke	0.041			0.127		

Note: Regression outputs are clustered by country (Australia, New Zealand and the United Kingdom).
Abbreviations: CI, confidence interval; IRR, incidence rate ratios.

policies around alcohol trade and access, online alcohol delivery or COVID-19 restrictions). Table 2 shows the results from three negative binomial regression models that investigated the relationship between latent class membership and alcohol consumption, clustered by country to account for country variance. Results from Model 1 suggest that alcohol consumption differs significantly between the reference *Alone* and the other classes ($p < 0.05$), with the exception of the *Alone and household* class ($p = 0.083$). Specifically, when compared to the *Alone* class, belonging to the *Household* (incidence rate ratio [IRR] 0.70), *Gatherings and household* (IRR: 0.62), and *Party* (IRR: 0.69) subgroups were associated with reduced alcohol consumption. On the other hand, the *Everywhere* (IRR: 1.23) subclass was significantly associated with increased alcohol consumption. While *Alone and household* subclass was associated with raised consumption, this increase was not significantly different from the *Alone* class (IRR: 1.09; $p < 0.05$). Model 2, which accounts for sex and age (modelling age as a quadratic term), produces a similar pattern of results as Model 1 with the exception that the *Alone and household* subclass now shows significantly increased alcohol consumption compared to the *Alone* subclass (IRR: 1.16, $p < 0.001$). After controlling for other covariates, the main effects for gender were significant, as female drinkers were associated with reduced alcohol consumption (IRR: 0.73, $p < 0.001$). Age was also significant in this model; the estimated number of standard drinks increased yearly until age 53, after which it declined with age.

Lastly, based on the results of Model 2 (see Table 2), Figure 3 illustrates a predictive margins plot illustrating the sex-and-age stratified relationship between latent class membership and alcohol consumption. The figure highlights differences between gender and age and alcohol consumption for each of the six classes. Figure 3 depicts that the alcohol consumption for people classified in the *Alone*, *Household* or *Household and gatherings* subclasses were similar in terms of sex- and age-related trends in alcohol consumption with the exception that the plotted curve estimates of total consumption were slightly higher for the *Alone* subclass relative to the

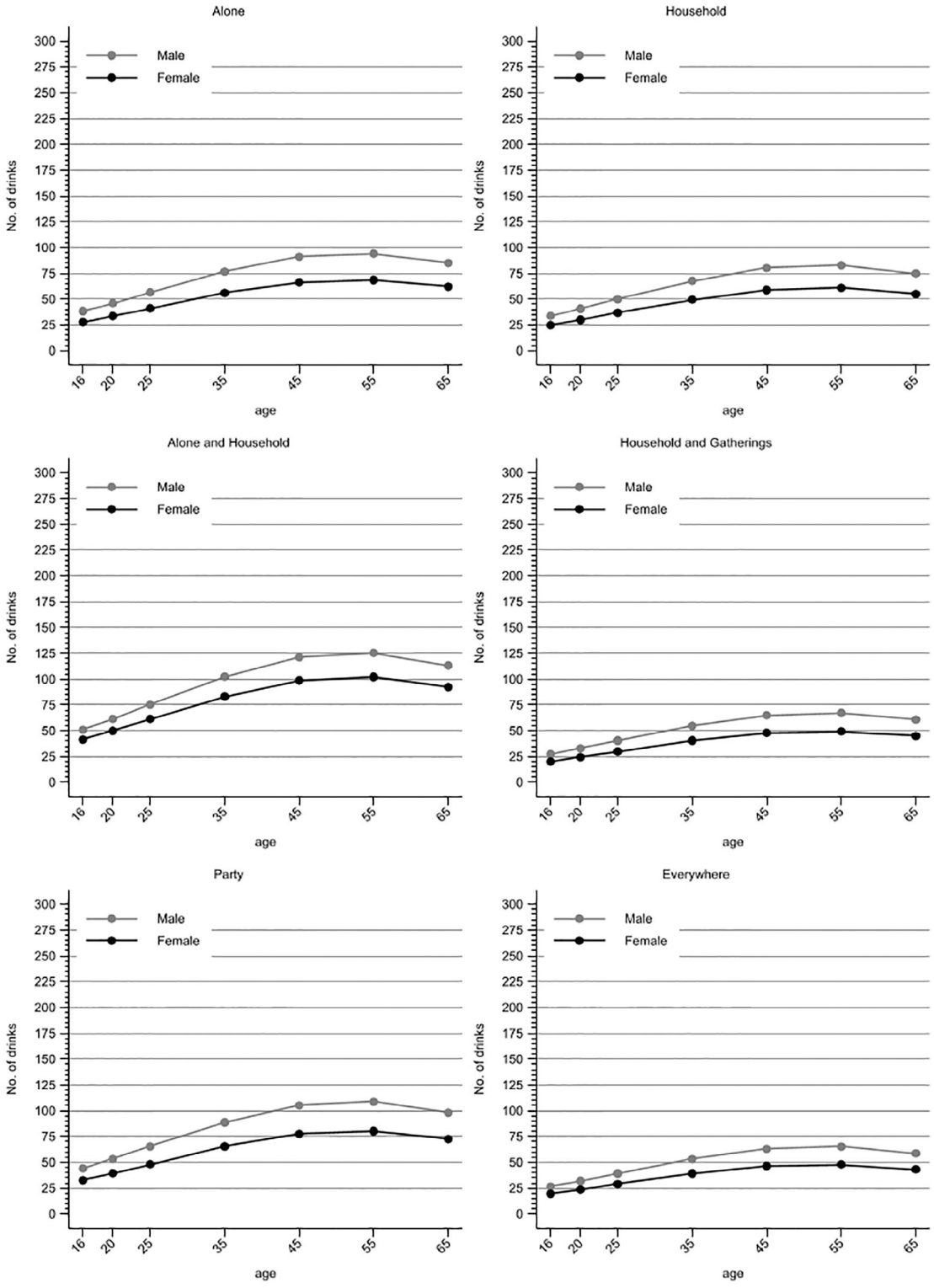

FIGURE 3 Predictive margins plot showing the number of standard drinks in the last month by sex and age for each drinking type classification.

Household subclass, and the curves for the *Household* subclass was slightly higher than for the *Gatherings and household* subclass (especially for respondents aged 45 years and over). By contrast, those classified in the *Alone* and *Household* subclasses had total alcohol consumption estimates that were typically higher than all other groups (especially for respondents aged between 45 and 55 years). Finally, for the *Party* subclass, the total

consumption gap seen between male and female respondents was typically the largest (especially for those over 25 years). Respondents classified in the drinks *Everywhere* category typically reported the lowest total consumption across the age bands; with the smallest total alcohol consumption between the genders.

4 | DISCUSSION

This study builds upon a growing body of research dedicated to investigating COVID-19-related changes in alcohol consumption [5] by providing a unique characterisation of the heterogeneity in alcohol consumption patterns found during the COVID-19-fueled transition towards home drinking. LCA demonstrated six distinct latent profiles of drinking contexts among a large sample of people who reported drinking alcohol in the last month. These subgroups were labelled as follows: *Household* (35.2%); *Alone* (32.3%); *Alone and household* (17.9%); *Gatherings and household* (10.3%); *Party* (3.2%) and *Everywhere* (1.1%). Before accounting for sex and age, the LCA suggests that *Everywhere* drinkers, those with a high probability of drinking in all settings, were more likely to report higher levels of alcohol consumption compared to the *Alone* subgroup. Considering that COVID-19 restrictions were in place in Australia, New Zealand and the UK during this time, with most licensed venues closed and large gatherings prohibited, this suggests that individuals who may have chosen to ignore these restrictions and attend 'underground' social gatherings, as well as drink at home, were more likely to drink an increased amount of alcohol during this time compared to those who drank solely at home.

Our results also showed a high level of alcohol consumption among those drinking alone compared to those who drank in broader contexts during the initial months of the COVID-19 pandemic. A longitudinal survey of 4298 American adults by Nordeck et al. [36] depicts a similar pattern, demonstrating a sustained increase in pandemic alcohol consumption among those living alone. While for many individuals, this may reflect a temporary response to isolative COVID-19 restrictions, we recommend that future research continues to explore this phenomenon considering evidence linking solitary drinking with mental health problems in adults [48] and young adults [49], including in our previous analyses of COVID-19-induced changes in alcohol use in this same cohort [17]. Further research on this topic may also assist in clarifying contradictory findings; for example, the review by Acuff et al. [5] found that those who lived with more people [11, 15, 16] were more likely to increase their overall alcohol consumption during the pandemic.

We also found a trend of increasing alcohol consumption as respondents' age increased, a finding that was consistent across latent classes. While this finding contradicts that of the review by Acuff and colleagues, which reported that the likelihood of increased alcohol consumption diminished with each decade over age 40 [5], the finding aligns with those from pre-pandemic international surveys (e.g., Australia [50], USA [51]), reporting high levels of alcohol consumption among older people. For example, the most recent Australian National Drug Strategy Household Survey shows an increasing linear relationship between age and the percentage of Australians drinking alcohol daily, with those aged 70+ most likely to drink daily [50]. Further analyses of these data found that 93% of Australians aged 60 and older were drinking at home, and recommended the implementation of interventions aimed at this age group focused on increased awareness of the harms of risky drinking (e.g., elevated risk of mortality, morbidity and health-care costs [52]) among older people [53].

In addition, we found that female respondents reported consuming less alcohol than males in all groups, and that this disparity between men and women was more pronounced at older ages. Although our study did not compare pre- and post-pandemic changes in alcohol use, one US-based study that found decreased alcohol use among females (compared to males) during the COVID-19 pandemic ascribed this finding to reduced access to alcohol due to COVID-19-related stress and financial burden [36]. Given our findings, future research may benefit from exploring sex-related trends in post-pandemic alcohol use to identify possible opportunities for policy responses. For those reporting increased alcohol use during the initial stages of COVID-19 restrictions, there is the possibility that this increased pandemic-related alcohol consumption may persist beyond the removal of COVID-19 restrictions, leading to increased risk of physical and mental health harms associated with risky drinking [18, 19]. As such, there is clear value in ongoing research exploring whether COVID-19-induced changes in alcohol consumption persist, particularly within the context of lacking public policy addressing home drinking [1, 54].

Our study has several notable strengths. To our knowledge, this is the first study to characterise the vast heterogeneity in where people consumed alcohol during COVID-19 and examine the association between these varied settings and alcohol consumption. We also explored these trends among a relatively large international sample. Third, we constructed our LCA methodology solely using variables relevant to drinking contexts, thereby producing interpretable subgroups that are focused on home drinking. For instance, while we

identified several pre-pandemic studies using LCA relevant to alcohol use [55–58], these are rarely focused on home drinking, and often combined alcohol-related variables with unrelated factors. Negative binomial regression analyses also substantiated the utility of our LCA, finding meaningful and statistically significant differences in alcohol consumption between these subgroups, and we used best-practices in LCA methods as outlined by Weller et al. [41] to guide model selection and study procedures.

Our findings are also subject to some limitations. First, our data represent a non-probability sample of self-selected respondents who used alcohol or other drugs in the past year, limiting the generalisability of our findings to the general population. Second, the self-reported nature of the GDS may have affected the accuracy of our results, but online surveys represent a fast, anonymous and low-cost way to collect data, especially during COVID-19-imposed restrictions. Next, the *Everywhere* class in our LCA consisted of only 53 participants, potentially skewing the results for this class in the negative binomial regression, but the small size of this group is to be expected in the context of restrictions on social gatherings in these three countries during May and June 2020. Fourth, the phrasing of the survey question assessing the number of standard drinks consumed ('in the last 30 days, how many standard drinks containing alcohol did you have on a typical day?') may have resulted in an underestimation of alcohol consumption. Fifth, our measure of financial hardship is limited in scope, resulting in a limited ability to understand the impacts of income or socio-economic status on respondents' alcohol consumption during initial COVID-19 restrictions Sixth, it is noteworthy that despite only 1.1% of the individuals in the drinking 'alone' class and 1.5% in the 'alone + household' latent class actually living alone, these subgroups accounted for half of the total sample. This finding may reflect the impact of the mandatory lockdowns during the survey period, which restricted people to drinking with only those in their household. However, it is important to consider that the alone subgroups also included individuals who were drinking at home while being in the company of others through videocalls. This may have led to an overestimation of the number of people in the 'alone' subgroups in comparison to typical circumstances. The associated harms of this type of home drinking alone with virtual company may be different from those of drinking in complete isolation. Seventh, the definition of a standard drink is not uniform across the countries, with the UK having a lower definition of 8 grams of ethanol compared to Australia and New Zealand's definition of 10 grams of pure ethanol used to define a standard drink. While we manipulated the data to correct for this difference, this manipulation itself could have introduced a bias towards increased alcohol consumption in the UK, particularly for those who were unaware of what constitutes a standard drink. Lastly, our study was an exploratory exercise drawing on a convenience sample and, as such, it should be noted that the results should be interpreted with caution. For example, the results of the six-subgroup LCA produced suboptimal average posterior probabilities. This may indicate that the data used in the analysis may not have been adequate to fully support the assumptions of the model. This limitation, in combination with the potential for underestimation of the model, underscores the need for future research to explore alternative approaches. The limitations of this study emphasise the importance of conducting further research in this area with more robust sampling and modelling methods to address the limitations of this exploratory analysis.

5 | CONCLUSION

This study used LCA to find six unique subgroups of drinking contexts during COVID-19 and investigates their associations with alcohol use. Our results highlight that there is meaningful variation in the drinking contexts of people in the early pandemic; a small group ($n = 53$) of respondents who reported drinking in home and social settings were most likely to report increased alcohol consumption, and respondents who reported drinking alone also reported a high level of alcohol consumption during this time. In contrast, belonging to subgroups characterised by drinking with household members or at parties, as well as younger age and female gender, was associated with reduced alcohol consumption. These findings substantiate the influence of the social environment on home drinking behaviours and highlight the need for further research exploring whether COVID-19-induced shifts in alcohol use persist as restrictions are progressively revoked.

AUTHOR CONTRIBUTIONS

Each author certifies that their contribution to this work meets the standards of the International Committee of Medical Journal Editors.

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CONFLICT OF INTEREST STATEMENT

Adam Winstock is the founder and owner of the Global Drug Survey. No other competing interests to declare.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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