Sleep Disturbances During Childhood Can Predict Adult Alcohol Consumption: A Longitudinal Cohort Study

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Thibaut Sabatier[1,2,*], Isabelle Kousignian[3], Ramchandar Gomajee[1], Katharine M. Barry[1], Maria Melchior[1], Murielle Mary-Krause[1]

[1] Sorbonne Université, INSERM, Institut Pierre Louis d'Épidémiologie et de Santé Publique (IPLESP), Equipe de Recherche en Epidémiologie Sociale (ERES), F75012, Paris, France
[2] Département d'Epidémiologie et de Promotion de la Santé, CHU de Rouen, U 1073, F 76000, Rouen, France
[3] Université Paris Cité, Unité de Recherche « Biostatistique, Traitement et Modélisation des données biologiques » BioSTM - UR 7537, F-75006 Paris, France

*Corresponding author. Department of Epidemiology and Health Promotion. Rouen University Hospital. U 1073. 37 boulevard Gambetta, F 76000 Rouen, France. Tel : +33 (0)2 32 88 18 06. E-mail: thibaut.sabatier1@gmail.com

Abstract

Background: Sleep disturbances (SDs) in childhood can negatively impact behavioral and emotional control, which can lead to an increase in risky behaviors, such as substance use, including alcohol.

Methods: Data from 2,132 subjects who participated in the French TEMPO cohort from 1991 to 2018 were used. Sleep disturbances observed from ages 3 to 16 years defined our exposure. Alcohol use in adulthood was measured by alcohol consumption trajectories ascertained by using Group-Based Trajectory Modelling (GBTM) and constitutes our outcomes. The association between sleep disturbances in childhood and alcohol consumption trajectories was studied using multinomial logistic regression.

Results: Sleep disturbances at ≤ 16 years were observed in 26.7% of participants. Three alcohol use trajectories were defined: "light-drinkers", "moderate-drinkers", and "heavy-drinkers". Accounting for many confounders, we found statistically significant associations between sleep disturbances and alcohol use trajectories. Using "light-drinkers" trajectory as reference, we found that compared to children with no sleep disturbances, those with sleep disturbances had a higher likelihood to be in the "moderate-drinkers" (ORa = 1.51; 95% CI = 1.09-2.10) and "heavy-drinkers" trajectory (ORa = 2.34; 95% CI = 1.27-4.34).

Conclusion: This study suggests that sleep disturbances in childhood are associated with an increased risk of higher alcohol consumption in adulthood and highlights the importance of healthy sleep, particularly in children and adolescents, to prevent the onset of certain risky behaviors.

Keywords: Sleep disturbances, alcohol consumption, trajectories, childhood, adulthood, longitudinal

Introduction

In France, alcohol consumption has steadily decreased over the past fifty years (Richard et al., 2019), yet it remains high compared to other countries in the world (WHO, 2018). Indeed, in 2020 the average alcohol consumption for each person aged 15 years and over was estimated at 2.28 glasses per day (OFDT, 2021). Furthermore, 23.7% of the population aged 18-75 years had a consumption exceeding the recommended amount of alcohol (*i.e.*, no more than 2 standard glasses per day and no more than 10 standard glasses per week) (Andler et al., 2021). In addition, studies have shown that the earlier the use of alcohol, the higher the risk of developing an addiction (DeWit et al., 2000). There is therefore a need for research on early risk factors related to alcohol consumption to identify high-risk populations and enable more targeted prevention campaigns to reduce the burden of alcohol problematic use.

Sleep regulation, particularly in children and adolescents, is essential for their health and proper development, as it plays a crucial role in the brain maturation process that occurs during this period of life (Dahl & Lewin, 2002; Logan et al., 2018). Therefore, sleep disturbances (SDs) occurring during this period can have multiple consequences, such as altering reward-related brain function and negatively impacting executive functions, particularly inhibitory processes (Harrison et al., 2000; Killgore, 2010), which are one of the main cores of executive functions (Diamond, 2013). SDs can be seen as a general symptom that encompasses many disorders (Locke, 2011), particularly insomnia disorders, which are characterized by difficulty in initiating sleep, maintaining sleep continuity, or poor sleep quality, as well as circadian rhythm sleep-wake disorders which include advanced or delayed sleep-wake phase disorders (AASM, 2014). These kinds of disorders can lead to an increase in risky behaviors, such as the consumption of psychoactive substances (Nigg et al., 2006; Hasler & Clark, 2013; Shochat et al., 2014).

Addictive behaviors and SDs are both multifactorial and share several vulnerability factors, such as gender (Lee et al., 1999; Eaton et al., 2008), externalizing and internalizing problems (Gregory & O'Connor, 2002; Shochat et al., 2014; Pedersen et al., 2018; Cioffredi et al., 2021), academic difficulties (Fakier and Wild, 2011), a young age of puberty (Dahl and Lewin, 2002; Patton & Viner, 2007) and marital instability (Doherty and Needle, 1991; Mannering et al., 2011). Addictive behaviors are known to contribute to SDs (Khurshid, 2018). Specifically, alcohol abuse and dependence appear to be associated with chronic sleep disturbances, including reduced slow-wave sleep and increased rapid-eye-movement sleep. Moreover, these disturbances often persist long into periods of abstinence and may contribute to relapse (Colrain et al., 2014). However, this relationship appears to be more complex and potentially bidirectional. Indeed, there is a growing body of longitudinal evidence indicating an association between SDs and alcohol consumption (Wong et al., 2004; Wong et al., 2009; Wong et al., 2010; Pieters et al., 2015; Mike et al., 2016; Hasler et al., 2017; Nguyen-Louie et al., 2018; Hasler et al., 2022). A recent paper reviews current evidence of prospective associations between sleep/circadian factors and alcohol use during adolescence and young adulthood, providing consistent evidence that various sleep/circadian factors – including but not limited to difficulties falling or staying asleep, lower overall sleep quality, shorter sleep duration, daytime sleepiness, and later sleep timing – in adolescence predict later alcohol involvement (Hasler et al., 2024). Some authors have proposed a conceptual model involving positive and negative reinforcement pathways that link sleep/circadian disruptions to alcohol use, further underscoring the potential reciprocal nature of this relationship (Hasler & Pedersen, 2020). These studies highlight the complex bidirectional relationship between sleep and alcohol use, suggesting that SDs may not simply be a consequence of alcohol use but also a potential contributing factor to its initiation and persistence.

Nevertheless, few studies have explored the long-term effects of childhood SDs on adult alcohol consumption (Hasler et al., 2016). Indeed, some studies have shown a link between childhood SDs and an early onset of alcohol use (Wong et al., 2004; Wong et al., 2009), while others have investigated short-term effects, i.e., within one-year (Pieters et al., 2015; Hasler et al., 2017; Hasler et al., 2022) or medium-term effects, i.e., approximately five years later (Nguyen-Louie et al., 2018), on adolescent alcohol use. An important aspect of alcohol consumption patterns is the heterogeneity of consumption levels over time. Indeed, drinking habits differ by age, with alcohol consumption frequency typically increasing with age, while the average quantity consumed per day tends to decrease (Richard et al., 2019). Therefore, in this study, we focused on alcohol consumption trajectories in early to mid-adulthood to account for the diversity of alcohol consumption behaviors and hence heterogeneity over time, with the hypothesis that there is a stronger association between SDs and the highest alcohol consumption trajectories.

In this context, the aim of our study, based on data from 2,132 subjects who participated in the French longitudinal TEMPO cohort between 1991 and 2018 is to investigate whether SDs between ages 3 to 16 years can predict adult alcohol trajectories in the general population. Fance which is a country with high level of alcohol use (WHO, 2018) provides an appropriate setting to evaluate this association.

Materials and methods

Participants

The TEMPO cohort study has been described elsewhere (Mary-Krause et al., 2017). Briefly, it was established in 2009 to follow-up young adults aged from 22 to 35 years old and investigate their mental health and substance use trajectories. All TEMPO participants had at least one parent who participated in the GAZEL Cohort study (Goldberg et al., 2007) and

initially all participated in a study on children's psychological problems in 1991 and 1999 (Fombonne and Vermeersch, 1997) (**Supplementary Figure 1)**. In 2009, all participants contacted in 1991 (n = 2,582), aged from 3 to 18 years old, were invited to participate at the TEMPO cohort (n = 1,103 respondents). In 2011, due to a high level of attrition (52.4%), recruitment was extended to all offspring of GAZEL study participants aged from 18 to 35 years (n = 689 new participants). Participants were also contacted in 2015 and 2018 (n = 786 and n = 864, respectively), yielding up to five waves of alcohol use measures: 1999, 2009, 2011, 2015 and 2018.

Overall, 3,401 participants completed at least one study questionnaire, with 2,316 being eligible for alcohol consumption trajectories (*i.e*. they were aged 17 and above in 1999) and after removing participants with missing data regarding alcohol consumption (n = 184), our analytical sample included 2,132 TEMPO participants with at least one measure of alcohol use.

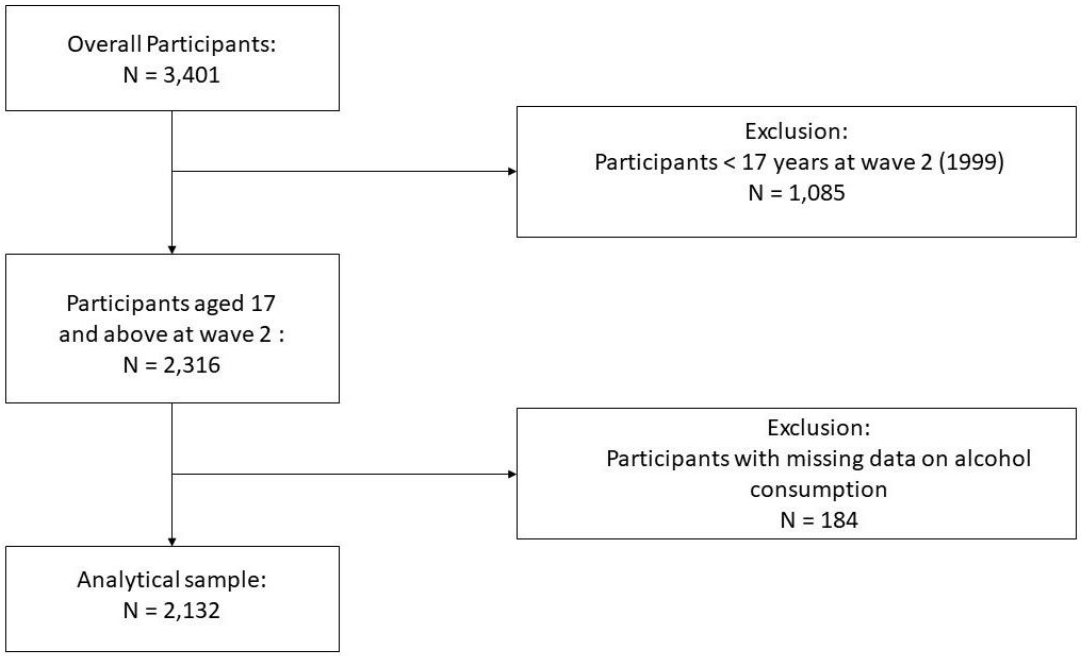

Figure 1. Flowchart of the study population.

The characteristics of TEMPO participants with missing data on alcohol consumption are detailed in the **supplementary methods** to gain a general understanding of the excluded population and to highlight potential selection bias.

The TEMPO cohort is managed by INSERM (French National Institute of Health and Medical Research) and received approval from the French National Committee for Data Protection (CNIL: Commission Nationale de l'Informatique et des Libertés).

Measures

Exposure variable: Sleep disturbances (SDs)

SDs in childhood (≤ 16 years) were defined using the item: "having trouble sleeping" present in both the Child Behavior Checklist-Parent Version (CBCL) (Achenbach, 1991) and the Child Behavior Checklist-Youth Version completed by participants' parents in 1991 and by participants themselves in 1999, respectively. The CBCL is a widely used instrument that measures common behavioral problems among children. Its reliability and validity have already been demonstrated in many societies, including Western Europe, on children from the general population. (Ivanova et al., 2007). Responses to this item were scored on a three-points rating scale (0 = not true; 1 = somewhat or sometimes true; 2 = often or very true). Due to the small number of scores equal to 2 (5.6%), we created a dichotomous variable (0 = not true; 1 = sometimes or often true). When both parental and self-reported measures were provided, the SDs score was coded as "sometimes or often true" if it occurred in a least one of the two possible measurements.

Outcome: Alcohol consumption trajectories

We created alcohol consumption trajectories among subjects aged 17 and above in 1999 based on at least one measure of the number of glasses of alcohol drank per week (*gpw*) between

1999 and 2018. As questions about alcohol consumption evolved over time, and because the computation of alcohol trajectories requires a common alcohol indicator across all waves, the number of *gpw* was homogenized and recoded uniformly in each study wave. In 1999, we used the number of glasses reported in the past week. In subsequent study waves, the number of *gpw* was calculated using the formula derived from the one proposed by Dawson (Dawson, 2003), as follows:

$$gpw = q \times \left(F_q - F_6\right) + (10 \times F_6)$$

where q denotes the usual amount of alcohol consumed on a single occasion, F_q is the frequency of drinking that quantity per week and F_6 the frequency of drinking 6 glasses or more on a single occasion per week. Prior to this approach, and because the original variables described above (i.e., q, F_q and F_6) being categorial, we used the midpoint between the two values of each category. In addition, we chose the value of 10 to represent the category "6 or more glasses".

Alcohol consumption trajectories were modeled using Group-Based Trajectory Modeling (Nagin, 1999; Nagin, 2009), a semiparametric probabilistic method that hypothesizes the existence of distinct developmental trajectories over time within one population. After selecting the number of trajectories with the best fit for our data using the Bayesian Information Criterion, all possible combinations of polynomial orders for trajectory shapes were tested. Each participant was assigned to a specific alcohol consumption trajectory group based on the posterior probability to belong to that group. Finally, to assess the quality of the model's fit to the data, posterior validity criteria were used such as average posterior probability of assignment to each trajectory group, odds of correct classification, and the difference between the estimated group probabilities and observed proportion assigned to each group (Nagin, 2009).

To validate the estimated trajectories with at least one measure of alcohol consumption, a sensitivity analysis was performed among participants with at least two measures of alcohol use (n = 1,270), as recommended by Nagin (Nagin, 2009).

Covariates

Several characteristics of children and parents have previously been identified as risk of children's sleeping problems and alcohol use in adulthood (Doherty and Needle, 1991; Lee et al., 1999; Dahl et Lewin 2002, Gregory and O'Connor, 2002; Wong et al., 2004; Patton & Viner, 2007; Eaton et al., 2008; Fakier and Wild, 2011) and were therefore taken into account in our study.

Participants' characteristics: *gender* (male vs. female); *childhood externalizing* and *internalizing disorders* at ≤ 16 years (yes vs. no) as captured by the CBCL (Achenbach, 1991) and reported by parents in 1991 or by participants themselves in 1999. Following the CBCL coding rules, we considered that a score above or equal to the 85th percentile was indicative of clinically significant externalizing or internalizing problems (Achenbach and Ruffle, 2000); *presence of academic difficulties* was measured by participants' grade retention at ≤ 16 years (yes vs. no); *age of puberty onset*, initially coded as "Precocious", "Normal" or "Delay" assessed retrospectively by parents in 1999, was recoded as "Precocious" or "Normal or delay" due to a small number of subjects in the last category.

Parental characteristics. Parental characteristics were reported in the yearly GAZEL cohort study (Goldberg et al., 2007) and included: *parental divorce* (yes vs. no) at ≤ 16 years; *occupational grade* ("Manager" vs. "Technician or administrative associate" and "Manual worker or clerk" ascertained by the parents' highest occupational grade; *parental tobacco smoking*, defined by the highest smoking level of either parent, ("Persistent smoker vs. "Former smoker" and "Non-smoker") before participants were ≤ 16 years and *parental*

alcohol misuse (yes vs. no). Parents were considered as misusers if their alcohol consumption was above four or three glasses of wine or beer for men and women, respectively, or involved at least one daily consumption of spirits.

Statistical analysis

Percentages of missing values across covariates varied from 0% to 55%, with a majority around 15%, only the age of puberty was missing for 55% of participants. Our exposure variable, SDs, was missing for 51.7% of participants (n = 1,102). Even if there is no consensus on the imputation of the exposure with many missing data, all missing data on the exposure variable and on covariates were imputed using multiple imputations by Fully Conditional Specification (Van Buuren et al., 2007) to maximize statistical power. In addition, excluding data based on the independent variable could have biased our results, as the resulting sample would be less representative. This is considered standard procedure by many to impute all independent variables (Austin et al., 2021; van Ginkel et al., 2020). Ten sets of imputations were performed. If the likelihood of being a complete case does not depend on the outcome after conditioning on the exposure and on main covariates, a complete-case approach gives unbiased results (Hughes et al., 2019). We therefore first investigated whether the chance of being a complete case depends on the study outcome after conditioning on the exposure and covariates, and then performed an additional sensitivity analysis with participants with complete exposure data and at least one measure of alcohol use (n = 1,030).

The association between SDs and alcohol consumption trajectories was studied using a multinomial logistic regression model, with "light-drinkers" set as the reference group. The adjusted model included all covariates that were associated with at least one drinking trajectory ($p < 0.20$) in bivariate regression models. Results are expressed in terms of adjusted

odds-ratios (ORa) and their associated 95% confidence intervals (95% CI). Results were deemed statistically significant at $p < 0.05$. All statistical analyses were carried out using SAS® 9.4.

Results

Alcohol consumption trajectories

We identified three trajectories of alcohol use (**Figure 2**): "light-drinkers" (62.6%) with a mean *gpw* of 1.1 (standard deviation (sd) = 0.2); "moderate-drinkers" (31.7%) with a mean *gpw* of 5.2 (sd = 0.9) and "heavy-drinker" (5.8%) with mean *gpw* of 17.9 (sd =4.9).

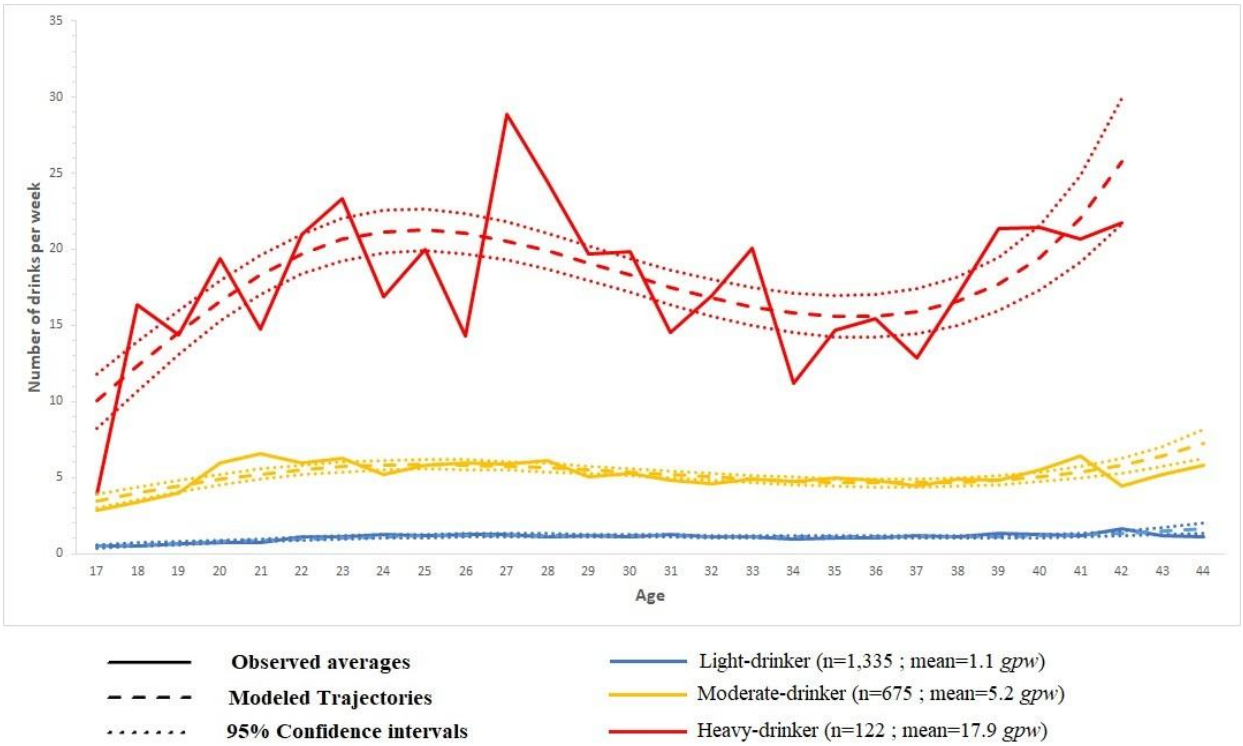

Figure 2. Estimation of the mean drinking trajectories and associated 95% confidence intervals among TEMPO subjects (n= 2,132).

Studied population characteristics

Table 1 describes the characteristics of our study population (n = 2,132) after imputations of missing data on the exposure variable and covariates. SDs at ≤ 16 years were observed in 26.7% of participants. Participants with externalizing and internalizing disorders at ≤ 16 years, those whose parents have low socioeconomic position and those with puberty at an early age were more likely to have had childhood SDs.

	Total	**SDs [a] ≤ 16 years old** (26.7%)	**No SDs ≤ 16 years old** (73.3%)	p*
Gender				
Women	59.0%	63.7%	57.2%	0.052
Men	41.0%	36.3%	42.8%	
Externalized disorders at ≤ 16 years				
Yes	13.9%	26.1%	9.5%	< 0.001
No	86.1%	73.9%	90.5%	
Internalized disorders at ≤ 16 years				
Yes	16.5%	36.1%	9.4%	< 0.001
No	83.5%	63.9%	90.6%	
Grade retention at ≤ 16 years				
Yes	11.3%	11.9%	11.0%	0.545
No	88.7%	88.1%	89.0%	
Puberty				
Precocious	15.4%	20.9%	13.4%	< 0.001
Normal or delayed	84.6%	79.1%	86.6%	
Parental divorce at ≤ 16 years				
Yes	5.5%	6.8%	5.0%	0.286
No	94.5%	93.2%	95.0%	
Parental occupational grade				
Manager	56.4%	59.0%	55.4%	
Technician/administrative associate	37.5%	31.5%	39.8%	0.005
Manual worker/clerk	6.1%	9.5%	4.8%	
Parental tobacco smoking				
Non-smoker	35.6%	36.0%	35.5%	0.273
Former smoker	29.9%	26.8%	31.0%	
Persistent smoker	34.5%	37.2%	33.5%	
Parental history of alcohol misuse				0.440
Yes	32.9%	31.8%	33.3%	

No	67.1%	68.2%	66.7%

Table 1. Characteristics of TEMPO study participants according to the presence of sleep disturbances (SDs) at ≤ 16 years, after imputing missing data (TEMPO Cohort study, France, 1991-1999, *n* = 2,132).

[a]: Sleep disturbances (SDs); *p = p-value with chi-square test.

Multinomial logistic regression

Based on the results of the bivariate regression models, gender, internalizing disorders at ≤ 16 years, puberty, parental occupational grade, parental tobacco smoking, and parental history of alcohol misuse were included in the multivariate regression model.

As shown in **Table 2,** after adjustment, SDs in childhood were associated with both the likelihood of being a "moderate-drinker" (ORa = 1.51, 95% CI = 1.09-2.10) and a "heavy-drinker" in adulthood (ORa = 2.34, 95% CI = 1.27-4.34).

Table 2. Multivariate multinomial logistic regression model (ORa [95% CI]) on the association between childhood sleeping difficulties and alcohol use in adulthood after imputations of missing data (TEMPO cohort study, 1991-2018, n = 2,132).

	Alcohol drinking trajectories[a]		
	"Light-drinker" n = 1335	"Moderate-drinker" n = 675	"Heavy-drinker" n = 122
SDs[b] prior to age 16 years			
No	Ref	1	1
Yes		1.51 [1.09-2.10]	2.34 [1.27-4.34]

[a]: After conditioning on gender, internalized disorders at ≤ 16 years, puberty, parental occupational grade, parental tobacco smoking and parental history of alcohol misuse.

[b]: sleep disturbances (SDs)

Sensitivity analysis for drinking trajectory

After identifying trajectories among participants over 16 years old with at least two measures of alcohol consumption (n = 1,270), the number and shape of alcohol trajectories did not

significantly change compared to the main analysis with a similar distribution found in each group compared to those obtained with at least one measure.

After imputations of missing data, the association between SDs and alcohol trajectories was studied among 1,270 participants. We found a similar proportion of SDs below 16 years old as in the main analysis (27.2%). Moreover, the subjects included in this analysis were more likely to be female ($p < 0.001$) (62.8% vs. 53.3%) and to have parents who were former smokers ($p < 0.001$) compared to those with only one measure of alcohol use.

In the adjusted multinomial logistic regression model, ORs of alcohol use associated with childhood SDs were similar to those observed in the main analysis (ORa = 1.71; 95% CI = 1.18-2.47 for the likelihood of being a "moderate-drinker" and ORa = 2.12; 95% CI = 0.95-4.70 for the likelihood of being a "heavy-drinker").

Sensitivity analyses for missing data

Among participants with at least one measure of alcohol use, participants with missing data on the exposure variable were more likely to have divorced parents at ≤ 16 years ($p = 0.023$), and to have parents who were current or former smokers ($p < 0.001$). After adjustment on covariates, the probability of being a complete case did not depend on the study outcome (ORa = 1.28; 95% CI = 0.83-1.96 and ORa = 1.20; 95% CI = 0.55-2.63 for the likelihood of being a "moderate-drinker" and "heavy-drinker" respectively) and was only associated with the exposure (ORa = 5.72; 95% CI = 3.86-8.48).

We then performed another sensitivity analysis among participants with at least one measure of alcohol use and complete exposure data (n = 1,030). This sensitivity analysis (**Supplementary Table 1**) yielded similar results with an association between SDs at ≤ 16

years with the likelihood of being a "moderate-drinker" and "heavy-drinker" (ORa = 1.46; 95% CI = 1.07-2.03 and ORa = 2.18; 95% CI = 1.21-3.92, respectively).

Discussion

Accounting for many individual and family characteristics associated with alcohol use, our study, performed in a community-based cohort of children followed up into adulthood, shows that individuals who had SDs at age ≤ 16 years have elevated odds of being moderate or heavy alcohol drinkers compared to participants who did not have SDs at age ≤ 16 years. As hypothesized, it appears that this association is stronger between SDs at age ≤ 16 years and the highest alcohol consumption trajectories.

Our results expand upon a growing literature suggesting a longitudinal link between SDs and alcohol consumption. Indeed, our findings are consistent with other longitudinal studies (Wong et al., 2004; Wong et al. 2009). However, these studies focused on the relationship between SDs and the onset of alcohol use. A recent longitudinal study (Troxel et al., 2021) showed that sleep trajectories are associated with trajectories of alcohol use between late adolescence and emerging adulthood. But, to our knowledge, our study is the first to examine the long-term association between SDs in childhood and trajectories of alcohol use in adulthood over 27 years follow-up period, spanning from 1991 to 2018.

To define our exposure, we chose to only consider participants' responses in 1999 rather than their parents' responses as in 1991. Indeed, in our study, parents underestimated their children's SDs, since they reported lower levels of SDs than their children (3.5% vs. 6.6% respectively). In addition, some studies have shown that adolescents' self-reports regarding their problems, particularly internalizing and externalizing problems, are more reliable than parents' reports (Begovac et al., 2004; Hope et al., 1999). Although the age range for assessing SDs encompasses a broad span and normative sleep patterns undergo

significant changes during this period (McLaughlin Crabtree & Williams, 2009), paralleled by fluctuations in the prevalence of diverse SDs (Petit et al., 2007), consequences of SDs, particularly on behavior, are likely to be similar in children and adolescents due to the brain development taking place at these ages (Dahl et Lewin, 2002; Maski & Kothare, 2013; Logan et al., 2018).

Our study has several limitations that must be considered before interpreting the results. First, one of the main limitations of our study is the use of self-reported data on a single question to define our exposure. Indeed, the use of a single dimension to characterize SDs is incongruent with the concept of multidimensional sleep health. Recent contributions in the sleep-alcohol literature increasingly adopt more comprehensive sleep frameworks (Hasler et al., 2022; Troxel et al., 2021) and reveal divergent associations based on different dimensions of sleep. However, we choose not to consider the "overtiredness" item present in the CBCL to characterize SDs, because overtiredness in childhood may be caused by factors other than sleep problems, such as inadequate nutrition (Roulet et al., 2005) or anemia (Janus & Moerschel, 2010) and could therefore be a source of classification bias. The use of self-reported data based on a single question, and thus a single item, to define sleep disorders could lead to an underestimation of their prevalence. Nevertheless, SDs at age ≤16 years were observed in 26.7% of TEMPO participants, which is consistent with what is reported in the literature which indicates that nearly 30 % of children have SD (Picard, 2008). Moreover, the literature does not provide the percentage of SDs occurring very often, making it difficult to interpret the 5.6% we found. This figure likely underestimates the true prevalence of SDs due to the definition used. The use of a single item to define the exposure may lead to classification bias. However, because the questionnaires were standardized, we believe that if there is classification bias, it is non-differential and would lead to an underestimation of the associations. Secondly, the TEMPO cohort is not representative of the French population.

Indeed, TEMPO cohort participants had at least one parent working for a large national energy company and who participated in a longitudinal study since 1989. Thus, our study was less likely to include participants who come from a very disadvantaged socio-economic background. However, persons with higher education are at elevated risk of binge drinking and conversely persons with lower education are at higher risk of chronic alcohol drinking (Com-Ruelle et al., 2008). Moreover, there is a social gradient in SDs, with more sleep complaints in children whose parents have low income and educational attainment (Grandner et al., 2010). However, because study participants were sufficiently heterogeneous, comparisons between groups were possible. Thirdly, all data were self-reported and measures such as age of puberty were determined retrospectively, which may induce recall bias. Nevertheless, this question was asked at an age close enough to puberty to minimize this bias. Fourthly, some potential confounders, such as ethnic identity or screen exposure (Jackson et al., 2018; Zayoud et al., 2020), could not be taken into account in this study. Controlling for these potential confounders might decrease the association between SDs and alcohol use. Finally, the chosen value of 10 to represent the “6 or more glasses” category may lead to an overestimation of alcohol consumption and thus be reflected in the shape and the number of drinking trajectories in our study. However, alcohol use trajectories estimated in this study are consistent with patterns observed in other studies (Maggs et al., 2005). Moreover, although the threshold of 60g of pure alcohol or more on at least one single occasion (equivalent to 6 standard drinks or more in France or 5 in USA (Rolland et al., 2017)) is commonly used in the literature to define heavy episodic drinking (WHO, 2018), there is no empirical basis for the designation of 6 (or 5) drinks as the threshold (Jackson, 2008). Furthermore, it seems that a significant percentage of college students who report heavy episodic drinking consume 2 or more times the established threshold (White et al., 2006). This is why the value of 10 was chosen to represent the "6 or more drinks" category. Finally, when we used the lower limit of

6 drinks to represent the "6 or more drinks" category, we found the same trajectory patterns and only the number of gpw in the highest consumption trajectory changed.

Despite these limitations, our study has many strengths that offset the previously cited limitations. First, we used longitudinal data to assess alcohol use prospectively over five different waves (1999, 2009, 2011, 2015 and 2018). Second, because this study was based on a large cohort of observational data beginning during childhood, we were able to include information on participants' SDs, externalizing and internalizing symptoms during childhood and adolescence, as well as parental substance use, which may predict later substance use. Third, this study also benefited from including sensitivity analyses that showed the robustness of our model in describing drinking trajectories and because, in this study, the chance of being a complete case did not depend on the outcome, the use of multiple imputation technique decreased bias that can occur from missing data and strengthened the robustness of our statistical analyses. Finally, we used validated measures of SDs, which guarantee reproducibility of our findings.

This study highlights the importance of healthy sleep, particularly in children and adolescents, to prevent the onset of certain risky behaviors such as alcohol consumption. To measure all dimensions of sleep health, future research could use more objective measures of sleep disturbances, such as a medical diagnostic test (e.g., a polysomnogram) or a specific questionnaire, including a sleep diary (e.g., the Sleep Disorders Questionnaire (SDQ; Douglass et al., 1994)). This study also emphasizes the need for public health to implement, as early as possible, prevention and promotion action to reduce SDs in this vulnerable population. Early identification of SDs in childhood is crucial. Indeed, Parents and caregivers should be educated about the signs and symptoms of SDs and the importance of promoting healthy sleep habits in children. Additionally, they should be informed about the potential risks associated with untreated SDs. One approach could involve developing a guide for

parents containing both information and practical advice, such as establishing a bedtime routine and limiting screen time before sleep to encourage healthy sleep habits and assist children in falling and staying a sleep.

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Disclosure of interest:

None of the study authors have conflicts of interest to declare.

Data availability statement:

The data underlying this article will be share on reasonable request. Research participants were guaranteed that the raw data they provided will remain confidential. To request access to the data, please send an email to cohorte.tempo@inserm.fr. Anonymized data can only be shared after explicit approval of the French national committee for data protection (Commission Nationale de l'Informatique et des Libertés, CNIL).

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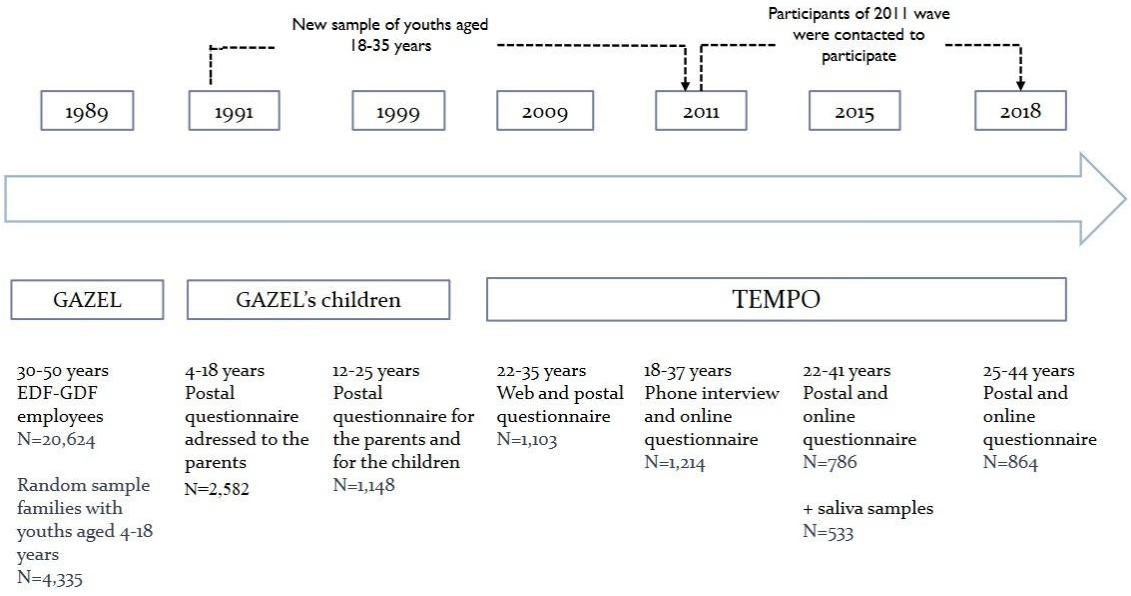
Supplementary materials:



Supplementary Figure 1. Timeline of TEMPO cohort.

Supplementary Methods: Characteristics of subjects with missing data on alcohol consumption compared to our analytical sample:

Compared to our analytical sample, TEMPO participants with missing data on alcohol consumption were more likely to have SDs at ≤ 16 years ($p < 0.001$), be male ($p < 0.001$), have externalizing disorders ($p < 0.001$), experienced a puberty at an early age ($p = 0.002$), have parents who divorced before the participant was 16 years old ($p < 0.001$) and were less likely to experience grade retention at ≤ 16 years ($p < 0.001$), have parents who were current or former smokers ($p = 0.001$) and have parents with a history of alcohol use ($p < 0.001$).

Supplementary Table 1. Multivariate multinomial logistic regression model (ORa [95% CI]) in subjects with at least one measure of alcohol use and complete exposure data, after imputations of missing data (TEMPO cohort study,1991-2018, *n* = 1,030)

	Alcohol drinking trajectories[a]		
	"Light-drinker" n = 649	"Moderate-drinker" n = 315	"Heavy-drinker" n = 66
SDs[b] prior to age 16 years			
No	Ref	1	1
Yes		1.46 [1.07-2.03]	2.18 [1.21-3.92]

[a]: After conditioning on gender, internalized disorders at ≤ 16 years, puberty, parental occupational grade, parental tobacco smoking and parental history of alcohol misuse.

[b]: Sleep Disturbances (SDs)