Exploring daily variations of drinking in the Swiss general population. A growth curve analysis

JEAN-LUC HEEB,¹ GERHARD GMEL,¹ JÜRGEN REHM,^{2,3,4} MEICHUN MOHLER-KUO⁵

1 Swiss Institute for the Prevention of Alcohol and other Drug Problems (SIPA), Lausanne, Switzerland

2 Research Institute for Public Health and Addiction, Zurich, Switzerland

3 Centre for Addiction and Mental Health, Toronto, Canada

4 Public Health Sciences, University of Toronto, Toronto, Canada

5 Institute for Social and Preventive Medicine, University of Zurich, Zurich, Switzerland

Abstract

This study aims to address the underlying trajectories of weekly individual drinking patterns by growth models and to relate differences in drinking patterns to socio-demographic and drinking characteristics of respondents. Data came from a two-stage stratified random subsample of 747 persons aged 15 years or more from a Swiss study on alcohol consumption using a within-subject design conducted between March 1999 and July 1999. Beverage specific assessment of daily alcohol consumption was obtained by a weekly drinking diary and other characteristics via telephone interviews. The diary had to be filled out on seven consecutive days. The growth models accounted for up to 37.6% of the initial error variance and provided evidence for two distinct, negatively correlated underlying trajectories of drinking patterns. The first trajectory described an increase in consumption from Monday to Sunday. The second trajectory was about a specific weekend consumption culminating on Saturday with a significantly higher growth rate among young people and heavy episodic drinkers than in other subgroups. Therefore, young and heavy episodic drinkers may be exposed to sudden adverse consequences of alcohol consumption during the weekend. Prevention efforts which are targeted to this subgroup should take its specific drinking pattern into account. Copyright © 2008 John Wiley & Sons, Ltd.

Key words: alcohol, drinking patterns, weekly drinking diary, weekend drinking, heavy drinking episodes

Introduction

In addition to the average volume of consumption, drinking patterns have become a high priority on the alcohol epidemiological research agenda (Rehm et al., 2003b). The impact of heavy drinking occasions has proved to be independent of volume, particularly in view of social consequences, including intentional and unintentional injury (Duncan, 1997; Duncan et al., 1999; Gmel and Rehm, 2003; Gruenewald et al., 1996; Gruenewald and Nephew, 1994; Rehm and Gmel, 1999; Rehm et al., 2003a; Treno et al., 1997; Treno and Holder, 1997), and its burden on disease has been

quantified recently (Rehm et al., 2004). There is increasing evidence that even among drinkers whose average alcohol consumption is moderate, heavy drinking occasions may be associated with health consequences including ischaemic heart disease (Rehm et al., 2004), liver disease (Rodés et al., 1999; Stranges et al., 2004), and overall mortality (Rehm et al., 2001; Rehm et al., 2006). High consumption levels on some days appeared to be particularly relevant when the volume of drinking was low at other times. Many studies showed increased rates of alcohol-related consequences such as violence, accidents, poisoning (e.g. Chenet et al., 2001;

Gmel et al., 2005; Pridemore, 2004), and ischaemic heart disease (Chenet and Britton, 2001; Chenet et al., 2001; Chenet et al., 1998; Evans et al., 2000; Willich et al., 1994) over weekends, suggesting a specific heavy drinking pattern at the end of the week. However, most of these studies only indirectly attribute daily variations in alcohol related consequences to a specific weekend drinking pattern, as they do not provide measures of daily alcohol consumption (for an exception see Gmel et al., 2005).

Indeed, research on drinking patterns has found that, compared with weekday drinking, the amount of alcohol consumed per day peaks over weekends in many countries (e.g. Sieri et al., 2002), emphasizing an overall cyclical weekly drinking pattern (Arfken, 1988). However, the research methodology most commonly used may be insufficient to address drinking patterns in an epidemiological perspective as it relies on differences between groups of drinkers, thus aggregating the individual patterns in the sample and breaking the resulting synthetic aggregate pattern down by temporal units, e.g. by presenting mean consumption per weekday (Leigh, 2000; Lemmens et al., 1992; Rehm, 1998). Due to the aggregation, the link at an individual level across temporal units is lost and the procedure is open to ecological fallacy (Morgenstern, 1998). By inspecting temporal variations on an aggregate level, for instance, it cannot be examined whether higher mean consumption over weekends is due to regular drinkers who increase their drinking at weekends, or to drinkers who consume heavily over weekends but abstain, or almost abstain, during the rest of the week.

To avoid the problems of analysing aggregate data, piecewise growth modelling of individual data will be used as a methodological strategy. This methodology provides two major advantages. First, growth trajectories – for instance weekly growth and weekend growth – can be used to model the observed individual drinking patterns across temporal units. Second, changes in growth parameters can be related to individual characteristics to account for variations in drinking patterns across subgroups.

The study includes socio-demographic and drinking characteristics as potential individual determinants of temporal drinking patterns. Compared with other health-relevant behaviours, drinking has been characterized predominantly as a social activity and variations in drinking patterns are therefore expected to reflect social aspects of alcohol consumption (Rehm et al.,

1996). Investigations of drinking patterns provided evidence of differences between socio-demographic or drinking subgroups when addressing various issues such as heavy episodic drinking occasions (Bondy, 1996), settings (Rossow, 1996; Single and Wortley, 1993), types of beverages consumed (Goldberg et al., 1995), drinking partners (Demers, 1997), or variations in consumption during the day (Dawson, 1996). With respect to variations between days, results stem mainly from earlier work done in North America (Arfken, 1988; Argeriou, 1975; Cahalan et al., 1969; Cahalan and Room, 1974; Harford and Gerstel, 1981). Temporal drinking patterns often relied on retrospective measures of alcohol consumption (Dawson, 1996), which may be prone to considerable measurement errors (Gmel and Rehm, 2004). In the present study, a prospective weekly drinking diary was used allowing for reports to be made immediately after consumption. Prospective measures may reduce memory flaws such as recall errors or omissions and should therefore yield more exact reports than retrospective measures (Gmel and Rehm, 2004; Leigh, 2000; Lemmens et al., 1992). Preventing memory flaws seems especially valuable when daily consumption is addressed, as undesirable averaging effects, such as biased self-reports towards mode (Duffy and Alanko, 1992; Khlhorn and Leifman, 1993), may attenuate daily differences of alcohol consumption. Previous research on the sample of this study showed that the prospective weekly drinking diary used in the present study yielded about 50% more alcohol consumption than retrospective measures and suggested that this difference was mainly attributable to memory effects (Heeb and Gmel, 2005a).

The present study thus aims to detect a specific weekend drinking pattern in the Swiss general population based on daily self-reports of consumption collected by a weekly drinking diary. Its central hypothesis is that the aggregate consumption over the week does not reflect a uniform and common drinking pattern, but can be segregated into a weekend drinking pattern, predominantly among young people or heavy episodic drinkers and a more regular drinking pattern in the majority of other drinkers.

Methods

Sample

Data were taken from a study on changes in alcohol consumption in Switzerland's resident population aged

15 years or more. The data used were obtained from the first wave of the study in Spring 1999, which included a within-subject design combining telephone interviews and a weekly drinking diary. Telephone interviews were carried out between 29 March and 17 May and the starting days for completing the diaries were between 8 April and 11 July (with all but nine diaries starting in April or May). The study used a two-stage random sample, stratified by linguistic region. As a first step, a random sample of households was drawn from addresses in the Swiss telephone directory. As a second step, the individuals living in the household were listed and an eligible member of the household was selected at random. Respondents were first contacted by telephone. Those unable to respond in German, French or Italian (the main national languages of Switzerland), or to participate for health reasons, were excluded (133 individuals). The final sample consisted of 4007 individuals, corresponding to a response rate of 74.8%, which was similar to or even higher than those found in other Swiss health surveys (BFS, 1994, 1998; Fahrenkrug and Müller, 1989; Gmel, 1996). After screening participants' frequency of alcohol consumption, detailed questions were restricted to those 2902 individuals who had at least one alcoholic drink per month during the six months preceding the interview (72.4%). A random subsample of 1061 past monthly drinkers was asked to fill out a diary on alcohol consumption. Diaries were sent to the respondents immediately after completing the telephone interview and they had to be filled out on seven consecutive days. The response rate was 72.9%, resulting in a final diary subsample of 773 individuals. Twenty-six individuals did not fill in the corresponding dates of the daily reports or missed at least one day of reporting. Because correct weekdays of consumption could not be obtained, these individuals were excluded from the analysis. The analyses were therefore based on 747 individuals. Daily alcohol consumption was recorded by diaries, while socio-demographic and other drinking characteristics stemmed from telephone interviewing.

Measures

In addition to the written weekly drinking diary, a quantity frequency instrument was used to address alcohol consumption during telephone interviews (about the reliability and validity of self-reports of alcohol consumption, see, for instance, Harris et al., 1994; Midanik, 1982; Sobell and Sobell, 1990). The

diary was intended to capture the daily variations in drinking patterns, while the quantity frequency instrument was intended to characterize the average level of drinking over a six-month reference period. Average consumption is generally addressed more accurately when a long reference period is used, as consumption may be based on atypical drinking occasions when its assessment covers a short reference period (Dawson, 2000; Stockwell et al., 1999). On both measures, consumption was assessed in standard drinks (beer 27.5 cl, wine 10.0 cl, and spirits 2.5 cl) and then converted to grams of pure alcohol per day according to volume percentages based on Swiss Alcohol Board data (Maurer et al., 1996). Standard drinks were specified to yield about the same quantity of pure alcohol for all beverages. Standard guidelines for prospective diaries have not yet been established, as they are still seldom used in alcohol research. However, to avoid forgetting, the principle is that respondents report each drink immediately after they have it, or, at the latest, at the end of each day in the diary during a consecutive number of days – seven for the weekly drinking diary (Leigh, 2000; Lemmens et al., 1992; Rehm, 1998). Prospective diaries could then be viewed as sets of successive 24-hours recalls. In the present study, the weekly drinking diary contained one separate page for each of the seven days. On each page, respondents had to indicate the date and the number of drinks they had according to time of day and beverage type. The numbers of drinks were to be reported in a table divided vertically according to time of day and horizontally according to beverage types. Time of day was categorized in "0h–6h", "6h–12h", "12h–14h", "14h–18h", "18h–20h", "20h–24h". The diary was beverage-specific for beer, wine and spirits with subdivisions for wine (white wine, red wine) and spirits (liquors, aperitifs or mixed drinks). Specific quantities were added up to yield alcohol consumption. Consumption was coded zero when respondents had no consumption. The quantity frequency instrument was not beverage-specific and multiplied the frequency of drinking occasions (seven-point scale, from "more than once a day" to "once a month") and the typical number of alcoholic drinks per occasion (six-point scale, from "11 drinks or more" to "1 or 2 drinks") in the six months before the telephone interview (for a description see Heeb and Gmel, 2005b).

Socio-demographic characteristics and drinking characteristics were gender; age (16–29 years, 30–59 years, 60 years or more); linguistic region (French or

Italian speaking, German speaking); household size (one person household, two or more person household); education (12 years or more, up to 11 years); episodic heavy drinking (six drinks or more for men/four drinks or more for women per occasion at least once a month during the six months before interview, six/four drinks or more per occasion less than monthly); and problematic drinking based on the seven alcohol problem items of the Alcohol Use Disorders Identification Test (AUDIT) (Babor et al., 1989; Saunders et al., 1993; Gmel et al., 2001, at least one alcohol problem item during the six months before interview that was positively answered, no positively answered item). The reference category for gender was female. For the other characteristics, reference categories correspond to the last category reported in brackets earlier. Two dummy-coded variables for age (16–29 years, 30–59 years) were used. The proportions in the diary subsample ($n = 747$) and in the rest of the sample ($n = 2902 - 747 = 2155$) did vary by less than 5% (male gender 48.5% in the diary subsample versus 50.7%; age 16–29 years 20.9% versus 18.9%; age 30–59 years 60.5% versus 56.3%; French or Italian speaking region 50.1% versus 51.0%; one-person household 28.1% versus 32.1%; education 12 years or more 38.8% versus 36.9%; at least monthly heavy episodic drinking 17.3% versus 15.8%; at least one positive item of problematic drinking 15.1% versus 16.1%).

Statistical analysis

Analyses include sample descriptions carried out with SPSS 13.0 (SPSS Inc., 2004) and calculation of individual growth models over the weekdays using HLM 5.04 (Bryk et al., 1996). HLM is suitable for individual growth models, as repeated measurements nested within respondents are hierarchically organized. Compared with other techniques about growth models such as multivariate repeated measures, hierarchical modelling allows one to address individual variations in growth curves directly (Willett, 1997). Its strength lies in the determination of the extent of individual variations around a mean growth trajectory and the prediction of the individual growth parameters by characteristics of the respondents. Level 1 refers to measurements over the seven weekdays and level 2 to the respondents. Both in descriptive and inferential statistics, probability inclusion weights based on linguistic region and the number of eligible persons in the household were used to account for the sampling design. The probability inclusion weights ranged between 0.10 and 3.91, which

is less likely to lead to inefficiency (coefficient of variation = 0.69; interquartile range of 0.51 to 1.56). As regards HLM, weighting was applied at level 2, as self-reported alcohol consumption at the respondents' level was of interest (Bryk et al., 1996). Stratification by linguistic region was modelled as a predictor since HLM 5.04 does not allow for a design-based analysis. Empirical Bayes estimates of level 1 coefficients, restricted maximum likelihood (RMC) estimates for variance, t tests for fixed coefficients and chi-square tests for variances were used.

Modelling the drinking patterns helped examine different growth curve models and emphasized distinct weekly and weekend growth trajectories. Therefore, one or two-piece models of linear or non-linear growth were examined. One-piece models assume the same underlying drinking trajectory ($Y_{ti} = \beta_{0i} + \beta_{1i}X_{1t} + \epsilon_{ti}$, where t indexes the day of the week, i indexes the individuals and ϵ_{ti} is a normal distributed error term with mean 0 and standard deviation σ). In two-piece models, patterns result from the combination of two distinct trajectories ($Y_{ti} = \beta_{0i} + \beta_{1i}X_{1t} + \beta_{2i}X_{2t} + \epsilon_{ti}$). For both one-piece and two-piece models, correlations of random coefficients between individual initial status and growth rates (i.e. $\text{corr}(\beta_0, \beta_1)$ for one-piece models and in addition $\text{corr}(\beta_0, \beta_2)$ and $\text{corr}(\beta_1, \beta_2)$ for two-piece models) were computed to examine how the patterns and the individual drinking level are related. After selection of the most suitable model, differences in growth curve parameters were linked to socio-demographic and drinking characteristics of the respondents. Prediction of individual growth curve parameters was intended to account for socio-demographic and drinking characteristics as determinants of growth trajectories in the selected model.

Exploratory examination of the data in the sample by days indicated that the growth in mean consumption can be represented approximately by the following coding scheme (Raudenbush and Bryk, 2002): 0 (Monday), 1 (Tuesday), 2 (Wednesday), 4 (Thursday), 6 (Friday), 12 (Saturday), 10 (Sunday), where consumption on Monday serves as initial status. It shows a slight increase from Monday to Wednesday followed by a steeper increase from Wednesday to Sunday, with an extra peak on Saturdays. This would a priori suggest building models that account for an increase in consumption over the week as well as for drinking peaks during the weekend on Saturdays. From the wide range of models examined, the following models, given coding

schemes running from Monday to Sunday, were retained for theoretical and explanatory reasons. The one-piece models, based on a unique weekly coding scheme, included (I) constant daily consumption: 0, 0, 0, 0, 0, 0, 0; (II) increment based on differences of daily mean consumption observed in the sample: 0, 1, 2, 4, 6, 12, 10; (III) constant non-zero increment: 0, 1, 2, 3, 4, 5, 6; and (IV) simple constant increment from Monday to Friday and doubled constant increment from Friday to Sunday: 0, 1, 2, 3, 4, 6, 8. Two-piece models, combining both weekly and weekend coding schemes, were (V) constant increment over the week as in (III) with a distinct short weekend trajectory: 0, 0, 0, 0, 0, 2, 1; (VI) constant increment over the week as in (III) and long weekend trajectory: 0, 0, 0, 1, 2, 7, 4; and (VII) weekly increment as in (IV) and long weekend trajectory: 0, 0, 0, 1, 2, 6, 2.

Model I, the simplest possible hierarchical model or intercept only model, accounts for inter-individual differences of the weekly mean in consumption. Because it contains no growth estimates, it serves as a starting point for evaluating the impact of growth in subsequent models. Each of the Models II, III and IV integrate a different unique growth trajectory that is supposed to account for the individual drinking patterns. Model II is useful for examining whether the drinking patterns at the individual level mirror the aggregate level pattern, as the trajectory corresponds to the daily mean consumption of the sample. In Model III, a linear growth model, individuals are supposed to constantly increase their consumption over the week. Model IV is a non-linear growth model, which adds to the constant increase over the week of Model III an additional constant increase from Thursday to Sunday. Model IV emphasizes a stronger increase in consumption during the weekend compared to Model III.

Individual trajectories may, of course, be insufficiently accounted for by a unique growth trajectory, especially as regards the consumption peak at the weekend. For instance, the aggregate drinking pattern may represent drinkers with a moderate increase in consumption over the week, as well as drinkers who predominantly have alcohol during the weekend. Therefore, the two-piece growth Models V, VI and VII express drinking patterns as the result of distinct weekly and weekend trajectories. Short and long weekend trajectories – starting either on Saturday or Thursday – were combined additively with the weekly growth of Models III and IV.

Results

Table 1 summarizes daily self-reports of alcohol consumption by socio-demographic and drinking characteristics. Most of the subgroups showed a similar overall drinking pattern based on daily means, namely a continuous increase in consumption over the week with a drinking peak on Saturdays. Exceptions were found in females (lower consumption on Tuesdays than Mondays) and respondents aged 60 years or more (highest consumption on Sundays). Though the drinking patterns were found to be fairly general, the variation in weekly increase in consumption across subgroups was substantial. Thus, the ratio between the day with highest consumption (Saturday or Sunday) and the day with lowest consumption (Monday) was two and a half times as high among respondents aged 15–29 years (4.10) than those aged 60 years or more (1.59).

One-piece growth models are presented in Table 2. Model I stated that significant differences in inter-individual weekly mean consumption accounted for 39.92% of the total variance (382.89). The inclusion of a non-zero growth trajectory in Models II, III and IV lead to a reduction of the unexplained variance at the level of the weekdays of Model I by about 20%. Individual growth rates differed significantly from zero. Individual variations of initial status and growth rates accounted for more than 50% of the total initial variance. Correlations of random coefficients were close to zero, indicating a poor linear relation between initial status and growth rate (Model II, $r = 0.12$; Model III, $r < 0.01$; Model IV, $r = 0.05$).

Including a distinct weekend trajectory in Models V, VI and VII, allowed additional reduction of the unexplained variance. As indicated in Table 3, individual variations in weekend growth rates were significant. Weekend growth trajectories together with weekly growth trajectories accounted for about 30% of the unexplained variance at the level of the weekdays of Model I. Inter-individual differences in initial status and growth trajectories explained about 60% of the total initial variance. Further analysis concentrated on Model VII, as this model showed the highest reduction of variance. Correlations between random coefficients generally confirmed the poor linear relationship between initial status and weekly growth rate found in one-piece models (Model V, $r = -0.08$; Model VI, $r = -0.23$; Model VII, $r = -0.23$). Similarly, correlations between initial status and weekend growth rate were low (Model V, $r = 0.18$; Model VI, $r = 0.23$; Model VII,

Table 1. Daily mean alcohol consumption by socio-demographic and drinking characteristics (in grams of pure alcohol per day)

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Gender							
Male (47.3%)	11.34	13.83	14.69	17.29	19.03	25.64	22.05
Female (52.7%)	6.66	6.10	7.22	8.27	10.27	16.84	15.29
Age							
15–29 years (23.2%)	4.96	6.84	6.85	8.02	13.13	20.32	14.13
30–59 years (62.9%)	9.53	9.94	11.25	13.35	14.70	21.60	19.80
60 years or more (13.9%)	12.42	13.79	14.98	16.39	15.26	19.45	19.79
Linguistic region							
French or Italian (30.6%)	10.78	12.01	13.20	13.59	17.35	26.65	21.20
German (69.4%)	8.03	8.76	9.67	12.07	13.12	18.52	17.29
Household size							
One person (15.7%)	10.84	12.16	13.08	13.67	17.84	21.25	18.18
Two or more persons (84.3%)	8.51	9.31	10.32	12.32	13.77	20.96	18.54
Education							
12 years or more (34.6%)	8.45	9.42	10.54	12.36	13.63	20.21	16.97
Up to 11 years (65.4%)	9.68	10.39	11.14	12.87	15.88	22.51	21.35
Heavy episodic drinking							
At least monthly (17.2%)	15.27	16.76	19.80	21.45	22.15	37.15	29.79
Less than monthly (82.8%)	7.55	8.31	8.88	10.69	12.81	17.66	16.14
Problematic drinking							
At least one positive item (17.0%)	12.74	15.48	18.27	20.51	22.32	28.18	27.26
No positive item (83.0%)	8.08	8.59	9.22	10.91	12.80	19.54	16.69
Total	8.87	9.76	10.75	12.53	14.41	21.00	18.49

Percentages in parentheses refer to the weighted proportions in the sample.

Table 2. Parameter estimates of one-piece growth Models I–IV

	Model I		Model II		Model III		Model IV	
Coding scheme	0, 0, 0, 0, 0, 0, 0		0, 1, 2, 4, 6, 12, 10		0, 1, 2, 3, 4, 5, 6		0, 1, 2, 3, 4, 6, 8	
<i>Fixed effects</i>	Coef.	<i>t</i> Ratio	Coef.	<i>t</i> Ratio	Coef.	<i>t</i> Ratio	Coef.	<i>t</i> Ratio
	(SE)	(df)	(SE)	(df)	(SE)	(df)	(SE)	(df)
Intercept/initial status	14.58*	27.76	9.54*	18.60	8.60*	15.95	9.40*	17.62
	(0.53)		(0.51)	(746)	(0.54)	(746)	(0.53)	(746)
Growth effect			1.01*	15.95	1.99*	15.20	1.51*	14.50
			(0.06)	(746)	(0.13)	(746)	(0.10)	(746)
<i>Random effects</i>	Var.	χ^2 (df)	Var.	χ^2 (df)	Var.	χ^2 (df)	Var.	χ^2 (df)
Intercept	152.84*	4836.64	116.14*	2416.21	109.40*	1804.84	120.89*	2199.64
		(746)		(746)		(746)		(746)
Growth rate			1.25*	1203.82	4.91*	1039.54	1.85*	1162.20
				(746)		(746)		(746)
Level 1 error	230.05		181.50		187.84		182.28	
Var. red. at level 1 ^a			21.10%		18.35%		20.77%	

* $p < 0.01$.

^aBased on level 1 error variance of Model I.

Table 3. Parameter estimates of two-piece growth Models V–VII

	Model V		Model VI		Model VII	
Weekly coding scheme	0, 1, 2, 3, 4, 5, 6		0, 1, 2, 3, 4, 5, 6		0, 1, 2, 3, 4, 6, 8	
Weekend coding scheme	0, 0, 0, 0, 0, 2, 1		0, 0, 0, 1, 2, 7, 4		0, 0, 0, 1, 2, 6, 2	
<i>Fixed effects</i>	Coef.	t Ratio	Coef.	t Ratio	Coef.	t Ratio
	(SE)	(df)	(SE)	(df)	(SE)	(df)
Initial status	9.58*	17.34	9.80*	17.33	9.79*	18.19
	(0.55)	(746)	(0.57)	(746)	(0.54)	(746)
Weekly growth rate	1.27*	8.02	0.85*	4.14	0.88*	6.12
	(0.16)	(746)	(0.21)	(746)	(0.14)	(746)
Weekend growth rate	2.84*	6.29	1.13*	6.44	1.17*	6.36
	(0.45)	(746)	(0.18)	(746)	(0.18)	(746)
<i>Random effects</i>	Var.	χ^2 (df)	Var.	χ^2 (df)	Var.	χ^2 (df)
Initial status	122.42*	1918.31	131.05*	1967.13	139.29*	2813.70
		(746)		(746)		(746)
Weekly growth rate	5.90*	883.95	11.16*	971.62	7.71*	1459.71
		(746)		(746)		(746)
Weekend growth rate	53.16*	1076.98	8.96*	1183.84	12.23*	1562.74
		(746)		(746)		(746)
Level 1 error	164.03		159.63		143.61	
Var. red. at level 1 ^a	28.70%		30.61%		37.57%	

* $p < 0.01$.^aBased on level 1 error variance of Model I.

$r = 0.28$). Correlations were stronger between weekly growth rate and weekend growth rate, indicating a negative linear association (Model V, $r = -0.44$; Model VI, $r = -0.73$; Model VII, $r = -0.71$).

Socio-demographic and drinking characteristics were included in Model VII to predict variations of initial status and growth rates. As shown in Table 4, significant associations concentrated mainly on the prediction of the initial status, whereas growth rates were widely uniform across subgroups. Except for education, the whole set of predictors was significantly associated with the initial status in accordance with descriptive findings in Table 1. No such association was found for the variations of the weekly growth rate. The weekend growth rate depended significantly on age and heavy episodic drinking. The weekend drinking trajectory, including a consumption peak on Saturdays, was accentuated among both young respondents and heavy episodic drinkers. Interaction effects of age and episodic heavy drinking would suggest that the weekend drinking trajectory was even strengthened in young

episodic heavy drinkers when compared to the additive model (results not shown).

Discussion

In the present study drinking patterns were addressed by piecewise growth modelling of individual data to avoid problems in analysing aggregate data. Individual daily alcohol consumption was pattern-driven and could not be reduced to the aggregate weekly drinking cycle. The examination of one and two-piece growth models provided evidence of two distinct patterns underlying individual drinking trajectories, accounting for up to 37.6% of the initial error variance. A first weekly pattern emphasized a regular increase in consumption from Monday to Sunday, while a second pattern focused on weekend drinking with consumption being highest on Saturdays. Both patterns were, to a large extent, negatively correlated and their correlation with the initial consumption level on Monday was low. The patterns, especially, did not behave in a cumulative way but were mutually exclusive. Thus, weekend

Table 4. Parameter estimates of Model VII with socio-demographic and drinking predictors of individual growth parameters

	Initial status		Weekly growth rate		Weekend growth rate	
	Coef. (SE)	t Ratio (df)	Coef. (SE)	t Ratio (df)	Coef. (SE)	t Ratio (df)
Intercept	7.08** (1.37)	5.16 (738)	0.71 (0.43)	1.67 (738)	−0.20 (0.54)	−0.38 (738)
Male gender	7.66** (0.93)	8.19 (738)	0.16 (0.29)	0.54 (738)	0.35 (0.37)	0.94 (738)
Age 15–29 years	−8.48** (1.54)	−5.52 (738)	−0.33 (0.48)	−0.70 (738)	1.60** (0.61)	2.63 (738)
Age 30–59 years	−5.31** (1.31)	−4.05 (738)	0.09 (0.41)	0.21 (738)	0.64 (0.52)	1.22 (738)
French or Italian linguistic region	2.83** (0.97)	2.93 (738)	−0.11 (0.30)	−0.38 (738)	0.67 (0.38)	1.75 (738)
One-person household	2.72* (1.14)	2.39 (738)	−0.30 (0.36)	−0.85 (738)	−0.07 (0.45)	−0.14 (738)
Education 12 years or more	−0.54 (0.97)	−0.56 (738)	0.36 (0.30)	1.17 (738)	−0.03 (0.38)	−0.09 (738)
At least monthly heavy episodic drinking	5.77** (1.31)	4.39 (738)	0.21 (0.41)	0.52 (738)	1.73** (0.52)	3.33 (738)
At least one positive item of problematic drinking	3.32** (0.35)	9.58 (738)	0.07 (0.11)	0.68 (738)	−0.20 (0.14)	−1.47 (738)

* $p < 0.05$; ** $p < 0.01$.

drinking was not compatible with a weekly increase in consumption. Also, growth rates of both weekly and weekend drinking trajectories were similar for high or low initial consumption. The growth rate of the weekend trajectories was highest among young drinkers, who had a low mean initial consumption compared with other age groups, as well as among heavy episodic drinkers, who on the contrary drank at a high level on average on Mondays. Socio-demographic and drinking characteristics mainly explained differences in the initial consumption level. As regards patterns, the only significant differences were found among young respondents and heavy episodic drinkers showing a higher growth rate of the weekend drinking trajectories. Thus, the relevancy of socio-demographic and drinking characteristics as predictors seems to apply to the static consumption level rather than to the dynamic patterns of drinking.

The drinking culture in Switzerland could therefore be characterized by the coexistence of a rather regular pattern, with a somewhat higher increase during the

weekend than during the week, and a specific weekend drinking pattern between Thursdays and Sundays. Though both patterns shared highest consumption on weekends, they may reflect two different social drinking habits. The first one may point basically to regular drinkers, who increase their consumption slightly during weekends due to time spent with family or friends on occasions such as invitations or eating out. This pattern may, for instance, apply to meal drinkers. Social drinking at weekends could be expected to result in higher quantities with unchanged frequency. The second pattern would, on the contrary, indicate an unstable frequency of drinking. Concentration of drinking over weekends rather than weekdays may be interpreted as tolerated consumption during leisure time and disapproved consumption during work time (see Dawson, 1996). This may be indicative of contextual night drinking at parties or in bars, especially as seen among young people. Interestingly, consumption peaks on Sundays according to the first pattern and on Saturdays according to the second would be consistent

with the difference between festive dominical drinking among regular drinkers and recreational drinking at parties or in bars among young or heavy drinkers. The weekend drinking pattern and not the weekly drinking pattern was characteristic for the consumption on Saturdays among young people (regression coefficients -0.33 , not significant (n.s.), versus 1.60 , $p < 0.01$) and heavy episodic drinkers (0.21 , n.s., versus 1.73 , $p < 0.01$).

Some caveats must be addressed when examining the results of the study. First, the results presented may not apply exactly to the Swiss general population, as the sampling was based on the telephone directory and some exclusion criteria were used (language, health status, and drinking status). Compared with the general population, less integrated groups may be especially underrepresented. Next, due to the short reference period of seven days, patterns may reflect unusual consumption events and therefore be less reliable. However, since this mainly concerns variations of the individual trajectories, which may counterbalance each other, the underlying weekly and weekend patterns can be expected to be rather stable in the short-term. Generalizations about short- or long-term patterns should be treated with caution, for instance in view of seasonal changes or the evolution of drinking habits. Also, data modelling was based on epidemiological considerations and an analytical approach was chosen to evidence the effect of socio-demographic and drinking characteristics on trajectories. Further systematic research on alternative underlying drinking patterns should therefore address the consistency of the trajectories (e.g. latent trajectory classes). Finally, both telephone and diary data were used, and the telephone interviews came first. Mode effects or a lag in time should play a minor role, as they should not be relevant to variables such as gender or age and even, in the case of a lag in time, to episodic heavy drinking and problematic drinking because of the reference period of six months used.

To understand adverse consequences of alcohol consumption, looking at the average amount of alcohol consumed only is not sufficient. The way alcohol is consumed, especially heavy drinking occasions, should also be taken into account (Miller et al., 2005; Rehm et al., 2003b). One can then distinguish between average volume and variability of drinking as potential risk sources. This distinction would be consistent with the organization of individual drinking trajectories evi-

denced in this study. Volume would be related to initial consumption, while variability would be at least partially captured by the weekend drinking pattern. In the same way that variability cannot not be reduced to volume, the weekend pattern did not correlate with initial consumption. In both cases, two independent static and dynamic dimensions of consumption must be considered in order to explain variations.

These findings are important for both epidemiology and prevention. In terms of epidemiology, the dynamics of drinking at risk seem to be related to an effective, observable drinking pattern. Young people and heavy episodic drinkers, especially those belonging simultaneously to both subgroups, may encounter higher risk rates on weekends because of their drinking pattern, which induces lower alcohol consumption during the weekdays. With regard to prevention, attention should be paid to weekend drinking especially among young heavy drinkers in avoiding undesirable social consequences of alcohol consumption. This includes measures taken against the drinking behaviour of this subgroup in the long run as well as selective measures adopted for controlling the adverse consequences of alcohol consumption when drinking occurs.

Acknowledgements

The study was supported by the Swiss Alcohol Board and by the National Institute on Alcohol Abuse and Alcoholism (R01 AA13346-01A1).

References

- Arfken CL. Temporal pattern of alcohol consumption in the United States. *Alcohol Clin Exp Res* 1988; 12: 137–42.
- Argeriou M. Daily alcohol consumption patterns in Boston: some findings and a partial test of the Tuesday hypothesis. *J Stud Alcohol* 1975; 36: 1578–83.
- Babor TF, De la Fuente JR, Saunders JB, Grant M. AUDIT – The Alcohol Use Disorders Identification Test: Guidelines for Use in Primary Health Care. Geneva: World Health Organization, Division of Mental Health, 1989.
- Bondy SJ. Overview of studies on drinking patterns and their reported consequences. *Addiction* 1996; 91: 1663–74.
- Bryk AS, Raudenbush SW, Congdon R. HLM: Hierarchical Linear and Nonlinear Modeling with the HLM/2L and HLM/3L Programs. Chicago, IL: Scientific Software International, Inc., 1996.
- Bundesamt für Statistik (BFS). Swiss Health Survey – Initial Findings. Neuchâtel: BFS, 1994.
- Bundesamt für Statistik (BFS). Swiss Health Survey – Initial Findings. Neuchâtel: BFS, 1998.

- Cahalan D, Room R. Problem Drinking among American Men. New Brunswick, NJ: Rutgers Center of Alcohol Studies, 1974.
- Cahalan D, Cisin IH, Crossley HM. American Drinking Practices: A National Study of Drinking Behavior and Attitudes. New Brunswick, NJ: Rutgers Center of Alcohol Studies, 1969.
- Chenet L, Britton A. Weekend binge drinking may be linked to Monday peaks in cardiovascular deaths. *Br Med J* 2001; 322: 998.
- Chenet L, Britton A, Kalediene R, Petrauskiene J. Daily variations in deaths in Lithuania: the possible contribution of binge drinking. *Int J Epidemiol* 2001; 30: 743–8.
- Chenet L, McKee M, Leon DA, Shkolnikov VM, Vassin S. Alcohol and cardiovascular mortality in Moscow: new evidence of a causal association. *J Epidemiol Community Health* 1998; 52: 772–4.
- Dawson DA. Temporal drinking patterns and variation in social consequences. *Addiction* 1996; 91: 1623–35.
- Dawson DA. Alternative measures and models of hazardous consumption. *J Subst Abuse* 2000; 12: 79–91.
- Demers A. When at risk? Drinking contexts and heavy drinking in the Montreal adult population. *Contemp Drug Prob* 1997; 24: 449–71.
- Duffy JCA, Alanko T. Self-reported consumption measures in sample surveys: a simulation study of alcohol consumption. *J Off Stat* 1992; 8: 327–50.
- Duncan DF. Chronic drinking, binge drinking and drunk driving. *Psychol Rep* 1997; 80: 681–2.
- Duncan DF, Donnelly J, Nicholson T, White J. Chronic drinking, binge drinking, and drunk driving II. *Psychol Rep* 1999; 84: 145–6.
- Evans C, Chalmers J, Capewell S, Redpath A, Finlayson A, Boyd J, Pell J, McMurray J, Macintyre K, Graham L. "I don't like Mondays" – day of the week of coronary heart disease deaths in Scotland: study of routinely collected data. *Br Med J* 2000; 320: 218–9.
- Fahrenkrug H, Müller R. Alkohol und Gesundheit in der Schweiz [Alcohol and Health in Switzerland]. Arbeitsbericht Nr. 20. Lausanne: Schweizerische Fachstelle für Alkohol- und andere Drogenprobleme (SFA), 1989.
- Gmel G. Antwortverhalten bei Fragen zum Alkoholkonsum. Non-response-bias in schriftlichen Nachbefragungen [Response behaviour for alcohol questionnaires. Non-response-bias in mailed surveys]. *Schweiz Z Soziol* 1996; 22: 285–301.
- Gmel G, Rehm J. Harmful alcohol use. *Alcohol Res Health* 2003; 27: 52–62.
- Gmel G, Rehm J. Measuring alcohol consumption. *Contemp Drug Probl* 2004; 31: 467–540.
- Gmel G, Heeb J-L, Rehm J. Is frequency of drinking an indicator of problem drinking? A psychometric analysis of a modified version of the alcohol use disorders identification test in Switzerland. *Drug Alcohol Depend* 2001; 64: 151–63.
- Gmel G, Heeb J-L, Rezny L, Rehm J, Mohler-Kuo M. Drinking patterns and traffic casualties in Switzerland – matching survey data and police records to design preventive action. *Public Health* 2005; 119: 426–36.
- Goldberg DM, Hahn SE, Parkes JG. Beyond alcohol: beverage consumption and cardiovascular mortality. *Clin Chim Acta* 1995; 237: 155–87.
- Gruenewald PJ, Nephew TM. Drinking in California: theoretical and empirical analyses of alcohol consumption patterns. *Addiction* 1994; 89: 707–23.
- Gruenewald PJ, Mitchell PR, Treno AJ. Drinking and driving: drinking patterns and drinking problems. *Addiction* 1996; 91: 1637–49.
- Harford TC, Gerstel EK. Age-related patterns of daily alcohol consumption in metropolitan Boston. *J Stud Alcohol* 1981; 42: 1062–6.
- Harris TR, Wilsnack RW, Klassen AD. Reliability of retrospective self-reports of alcohol consumption among women: data from a U.S. national sample. *J Stud Alcohol* 1994; 55: 309–14.
- Heeb J-L, Gmel G. Measuring alcohol consumption: a comparison of graduated frequency, quantity frequency and weekly recall diary methods in a general population survey. *Addict Behav* 2005a; 30: 403–13.
- Heeb J-L, Gmel G. Spreading interviews over time in health surveys: do temporal variations of self-reported alcohol consumption affect measurement? *Subst Use Misuse* 2005b; 40: 1015–33.
- Kühlhorn E, Leifman H. Alcohol surveys with high and low coverage rate: a comparative analysis of survey strategies in the alcohol field. *J Stud Alcohol* 1993; 54: 542–54.
- Leigh BC. Using daily reports to measure drinking and drinking patterns. *J Subst Abuse* 2000; 12: 51–65.
- Lemmens PH, Tan ES, Knibbe RA. Measuring quantity and frequency of drinking in a general population survey: a comparison of five indices. *J Stud Alcohol* 1992; 53: 476–86.
- Maurer T, Blanchard N, Helfer M. Der Verbrauch alkoholischer Getränke in der Schweiz 1880–1995 [Consumption of Alcoholic Beverage in Switzerland 1880–1995]. Bern: Eidgenössische Alkoholverwaltung (EAV), 1996.
- Midanik LT. The validity of self-reported alcohol consumption and alcohol problems: a literature review. *Br J Addiction* 1982; 77: 357–82.
- Miller P, Plant M, Plant M. Spreading out or concentrating weekly consumption: alcohol problems and other consequences within a UK population sample. *Alcohol Alcohol* 2005; 40: 461–8.
- Morgenstern H. Ecologic studies. In Rothman KJ, Greenland S (eds) *Modern Epidemiology*. Philadelphia, PA: Lippincott-Raven Publishers 1998: 459–80.
- Pridemore WA. Weekend effects on binge drinking and homicide: the social connection between alcohol and violence in Russia. *Addiction* 2004; 99: 1034–41.

- Raudenbush S, Bryk AS. Hierarchical Linear Models: Applications and Data Analysis Methods. Newbury Park, CA: Sage Publications, 2002.
- Rehm J. Measuring quantity, frequency, and volume of drinking. *Alcohol Clin Exp Res* 1998; 22: 4S–14S.
- Rehm J, Gmel G. Patterns of alcohol consumption and social consequences. Results from an 8-year follow-up study in Switzerland. *Addiction* 1999; 94: 899–912.
- Rehm J, Greenfield TK, Kerr W. Patterns of drinking and mortality from different diseases – an overview. *Contemp Drug Probl* 2006; 33: 205–35.
- Rehm J, Greenfield TK, Rogers JD. Average volume of alcohol consumption, patterns of drinking and all-cause mortality. Results from the U.S. National Alcohol Survey. *Am J Epidemiol* 2001; 153: 64–71.
- Rehm J, Gmel G, Sempes CT, Trevisan M. Alcohol-related morbidity and mortality. *Alcohol Res Health* 2003a; 27: 39–51.
- Rehm J, Room R, Graham K, Monteiro MG, Gmel G, Sempes CT. The relationship of average volume of alcohol consumption and patterns of drinking to burden of disease: an overview. *Addiction* 2003b; 98: 1209–28.
- Rehm J, Ashley MJ, Room R, Single E, Bondy SJ, Ferrence RG, Giesbrecht N. On the emerging paradigm of drinking patterns and their social and health consequences. *Addiction* 1996; 91: 1615–21.
- Rehm J, Room R, Monteiro MG, Gmel G, Graham K, Rehn N, Sempes CT, Frick U, Jernigan D. Alcohol use. In Ezzati M, Lopez AD, Rodgers A, Murray CJL (eds) *Comparative Quantification of Health Risks: Global and Regional Burden of Disease Attributable to Selected Major Risk Factors*. Geneva: World Health Organization (WHO) 2004: 959–1108.
- Rodés J, Salaspuro M, Sørensen TIA. Alcohol and liver disease. In MacDonald I (ed.) *Health Issues Related to Alcohol Consumption*. Oxford: Blackwell Science Ltd 1999: 395–450.
- Rossow I. Alcohol-related violence: the impact of drinking pattern and drinking context. *Addiction* 1996; 91: 1651–61.
- Saunders JB, Aasland OG, Babor TF, De la Fuente JR, Grant M. Development of the Alcohol Use Disorders Identification Test (AUDIT): WHO collaborative project on early detection of persons with harmful alcohol consumption – II. *Addiction* 1993; 88: 791–804.
- Sieri S, Agudo A, Kesse E, Klipstein-Grobusch K, San-José B, Welch AA, Krogh V, Luben R, Allen N, Overvad K, Tjønneland A, Clavel-Chapelon F, Thiebaut A, Miller AB, Boeing H, Kolyva M, Saieva C. Patterns of alcohol consumption in 10 European countries participating in the European Prospective Investigation into Cancer and Nutrition (EPIC) project. *PublicHealth Nutr* 2002; 5: 1287–96.
- Single E, Wortley S. Drinking in various settings as it relates to demographic variables and levels of consumption: findings from a national survey in Canada. *J Stud Alcohol* 1993; 54: 590–599.
- Sobell LC, Sobell MB. Self-report issues in alcohol abuse: state of the art and future directions. *Behav Assess* 1990; 12: 91–106.
- SPSS Inc. SPSS Base 13.0 User's Guide. Chicago, IL: SPSS Inc., 2004.
- Stockwell T, Dawson DA, Holder HD, Jernigan D, Medina-Mora EM, Single E. International Guidelines for Monitoring Alcohol Consumption and Harm: Report to the World Health Organization Programme on Substance Abuse. Perth, WA: National Centre for Research into the Prevention of Drug Abuse, Curtin University, 1999.
- Stranges S, Freudenheim JL, Muti P, Farinara E, Russell M, Nochajski TH, Trevisan M. Differential effects of alcohol drinking pattern on liver enzymes in men and women. *Alcohol Clin Exp Res* 2004; 28: 949–56.
- Treno AJ, Holder HD. Measurement of alcohol-involved injury in community prevention: the search for a surrogate III. *Alcohol Clin Exp Res* 1997; 21: 1695–1703.
- Treno AJ, Gruenewald PJ, Ponicki WR. The contribution of drinking patterns to the relative risk of injury in six communities: a self-report based probability approach. *J Stud Alcohol* 1997; 58: 372–81.
- Willett JB. Measuring change: what individual growth modeling buys you. In Amsel E, Renninger KA (eds) *Change and Development: Issues of Theory, Method, and Application*. Mahwah, NJ: Lawrence Erlbaum Associates 1997: 213–43.
- Willich SN, Lowel H, Lewis M, Hormann A, Arntz HR, Keil U. Weekly variation of acute myocardial infarction. Increased Monday risk in the working population. *Circulation* 1994; 90: 87–93.
- Correspondence: Jean-Luc Heeb, Swiss Institute for the Prevention of Alcohol and other Drug Problems, Avenue Louis-Ruchonnet 14, P. O. Box 870, CH-1001 Lausanne, Switzerland.*
Telephone +41 21 3212963
Fax +41 21 3212940
Email: jlheeb@sfa-ispa.ch