

Agent-based modeling of College Drinking Behavior and mapping of system dynamics of alcohol reduction using both environmental and individual-based intervention strategies

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Abstract

Alcohol use is prevalent among college students in the US and is the leading cause of many alcohol-related consequences such as injury, driving under influence, and sexual assault. The problem of college drinking involves complex individual, social, and cultural factors. By viewing college drinking as a complex system problem, this paper describes two components necessary for the full development of a simulation-based dynamic agent model for alcohol use in college. The first component is a basic agent-based model that explores the dynamic of college drinking. The second component discusses the use of system dynamic modeling to explore the causal relationship between various personal/environmental factors and alcohol consumption. The paper also discusses important leverage points for intervention strategies, especially in the context of targeting both high-risk and low- to medium-risk drinkers in college.

1. Introduction

Alcohol use is pervasive among college students in the United States (NIAAA, 2002), O'Brien and colleagues (2006) found that 54.4% of undergraduate current drinkers participating in the Study to Prevent Alcohol-Related Consequences (SPARC) College Drinking Survey reported getting drunk at least once in a typical week. Despite heightened awareness of the problems associated with excessive drinking among college students, and an increase in prevention efforts, rates of binge or heavy episodic drinking have remained consistent and stubbornly high between 1993 and 2001 (Wechsler et al. 2002). Many factors contribute to alcohol use among college students. Social practices that encourage college drinking are ingrained in numerous levels of students' environments (Presley et al. 2002; Dowdall & Wechsler 2002), and many students perceive alcohol as necessary for social success (Schulenberg & Maggs 2002). Students, parents, and alumni often endorse a tradition of "study hard, party hard." Campus leaders may be ambivalent about efforts to curb student drinking, viewing it as an innocent and unavoidable rite of passage not amenable to policy change or administrative influence (DeJong 2002).

Dynamic modeling has proved to be a powerful way to explore complex social dynamics and interaction of individuals with environmental influences in modifying their behavior. This computational approach is especially suitable for modeling drinking behavior. Gorman et al. (2006) proposed a preliminary agent-based model (ABM) for examining the drinking behavior of drinkers. Building upon their prior work in drinking, the authors modeled the transitions among three types of agents—susceptible nondrinkers, current

drinkers, and former drinkers. Under the dynamic model, an individual can move from one type to another, and thus type membership is transient—e.g., a susceptible nondrinking student entering college has a positive probability of becoming a drinker over an iteration, which represents a time point such as a month. On the other hand, a drinker can also become a nondrinker. The dynamic model is consistent with current research in alcohol behavior. For example, “maturing out” and “natural recovery” of young drinkers are more the rule than the exception. Particularly, for drinkers in college, the dynamic pattern of alcohol consumption behavior is the norm, and to a certain extent supports the notion that college drinking is a social process that college students necessarily experience. While some of the young drinkers develop into alcohol-dependent adults, most of them do not. Dawson et al. (2005) showed that even among those classified as alcohol dependent, as many as 75% will move out of this class over a 1-year period.

The dynamic nature of alcohol use in college has implications for designing intervention strategies. First, it is now widely recognized that health behaviors, including high-risk drinking by college students, are shaped by multiple influences, including intrapersonal (individual) factors; interpersonal (group) factors; institutional factors; community factors; and public policies (Stokols 1996; DeJong & Langford 2002; McKinlay 1993). Historically, most interventions addressing high-risk drinking by college students have focused on individuals or small groups. These efforts typically seek to affect knowledge, attitudes, or behavior related to high-risk drinking (Boyd & Faden 2002; Larimer & Cronce 2002). Although these traditional programs have mostly focused on intra- and interpersonal factors, recent research has shown that drinking behavior, including high-risk drinking by college students, is influenced by environmental factors as well. Institutional factors associated with higher rates of drinking or alcohol-related problems include having a predominantly white student body, being a co-educational institution (as opposed to women-only), being a 4-year (as opposed to a 2-year) institution, and the presence of a Greek (fraternity and sorority) system (Presley et al. 2002). There is also evidence that students who live on-campus and those who live in a fraternity or sorority house are more likely to drink heavily and experience alcohol-related problems (Presley et al. 2002). More recently, the SPARC study—an 8-year study of a coalition-based environmental intervention trial that involves 8 colleges in North Carolina (Wolfson et al. 2011)—showed that environmental changes in colleges through community-organizing and coalition-based intervention can also be effective vehicles for achieving positive environmental changes in reducing college drinking. Thus, the dynamic of drinking behavior on college campuses could potentially be modified through changes in the schools’ ecology.

A second important implication of the dynamic nature of drinking behaviors among college students is that it is likely that the individual or small group approach and

the environmental approach will differentially affect the behaviors of different groups of drinkers. Figure 1 shows several classes of drinkers—low-risk, medium-risk, high-risk, and alcohol-dependent (AD). The so-called “pyramid of alcohol problem” delivered a visual picture of the distribution of different classes of drinkers. Dawson et al. (2004) reported that the prevalence of AD drinkers was 4% and at-risk users constitute 25% of the non-institutionalized U.S. population. The remaining 71% either abstained or were low-risk users. On college campuses, environmental changes, such as shifts in the drinking culture of a college, have the potential to most effectively reduce drinking in low- to high-risk drinkers but are less likely to have an effect on AD drinkers. High-risk and dependent drinkers are more likely to respond to individuals or small-group- based programs. Specifically, screening (S) and brief intervention (BI) are recommended for at-risk drinkers, whereas screening and referral to treatment (RT) are recommended for AD drinkers.

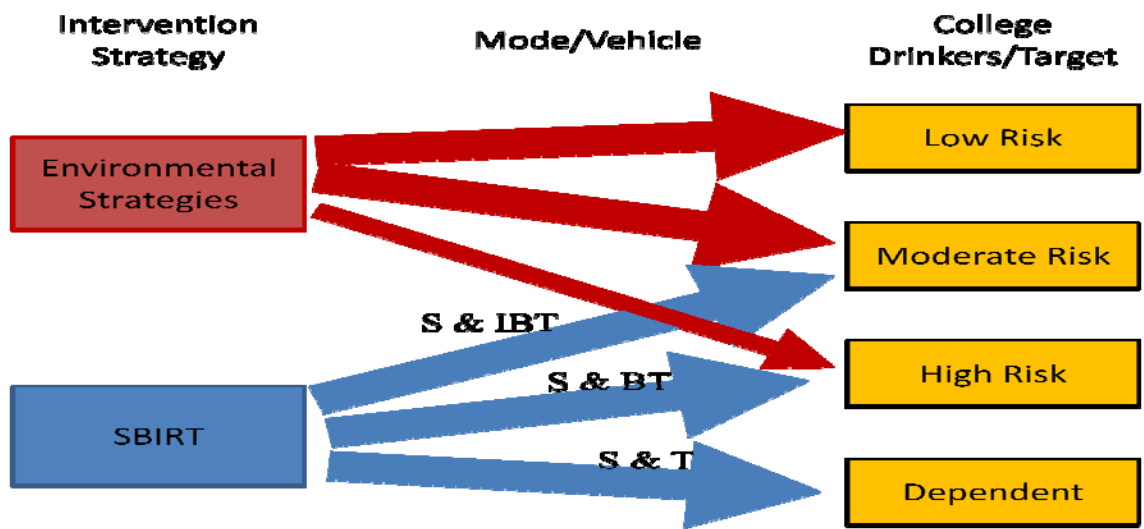


Fig. 1. Differential effects of intervention strategies on drinkers at different levels of risk. SBIRT stands for Screening, Brief, Intervention, Referral, and Treatment.

The purpose of this paper is to first adapt a culture-based ABM for modeling college drinking and for exploring the basic dynamics of drinking behavior in a college setting in which a class of freshman (1/4 of the college population) enters into the agent population every 12 months, while a class of seniors (another 1/4 of the college population) leaves the population. Within the ABM, the proportions of current drinkers and former drinkers (current nondrinkers) serve as a proxy for the “alcohol culture” of the specific college. A second goal of the paper is to use a causal-loop diagram (Sterman 2000) as a basis for exploring plausible system-dynamic (SD) models and to map causal effects of environmental intervention, and to use individual and small-group-based interventions when they are applied to leverage points identified in ABM. Two

specific causal-loop diagrams will be considered: an environmental intervention SD model for changing the “alcohol culture,” and a Screening, Brief Intervention, and Referral to Treatment (SBIRT) intervention SD model for targeting high-risk and AD individuals.

Figure 2 shows the intended effect of these two different types of intervention. In Fig. 2(a), a risk spectrum of college drinking is shown—the x-axis represents the risk level in drinking, whereas the y-axis represents the frequencies of the college drinkers at various risk levels. The tail-end of the distribution represents the high-risk and alcohol-dependent drinkers. Figure 2(b) represents the intended effects of an environmentally based intervention—shifting the entire distribution to lower risk. However, under this strategy, the tail-end of the distribution is likely to remain relatively thick. Figure 2(c) represents the intended effects of SBIRT interventions—moving the high-risk individuals to lower-risk levels and compressing the long tail-end of the distribution. Because individual and group-based programs are not likely to have an effect on the entire population, the median of the distribution is not likely to be affected by such programs. When both types of intervention are applied, the intended effect is both to shift the risk distribution to the left and to compress the tail-end of the high-risk distribution (Fig. 2(d)). In the section on SD modeling, we will further discuss possible causal effects from a system perspective, as well as how the two types of intervention could affect drinking behavior.

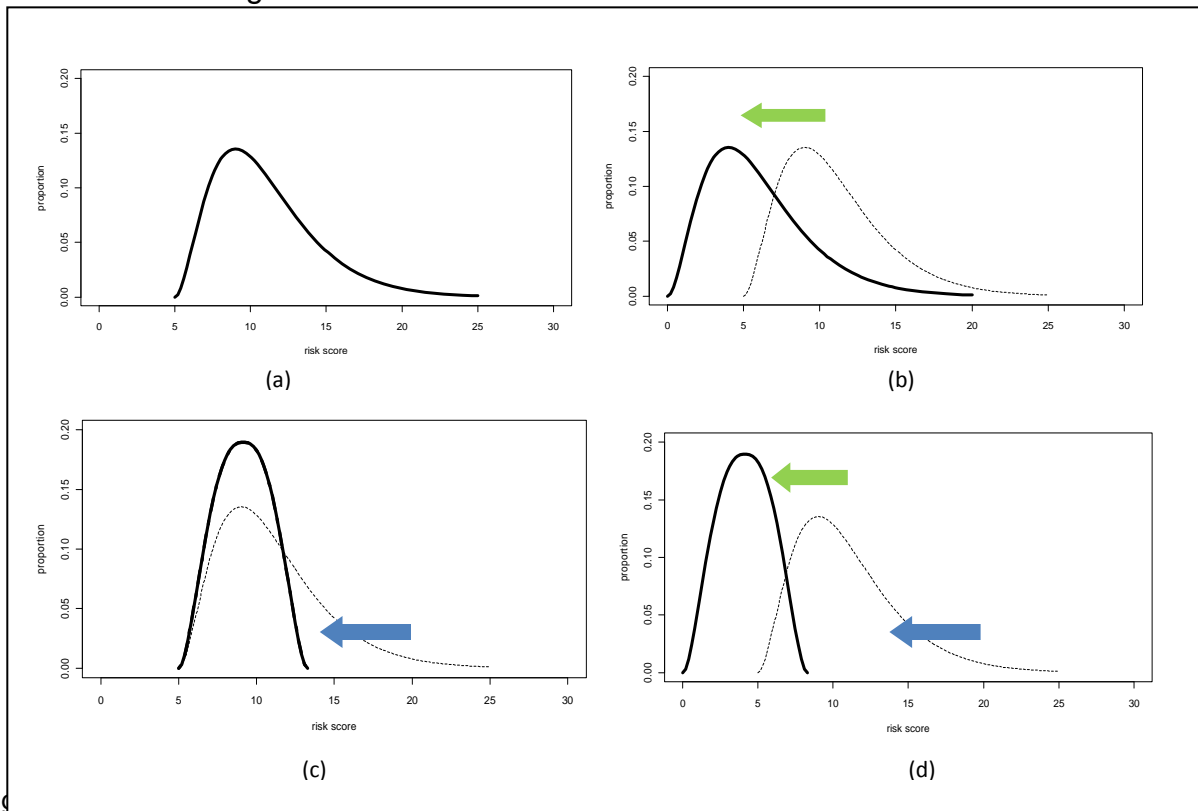


Fig. 2. Risk spectrum of college drinking. The horizontal axis represents risk level, and the vertical axis represents the proportion of the population. (a)

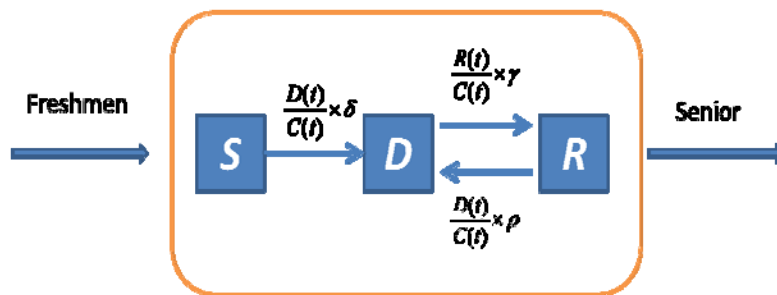
Risk spectrum without intervention, (b) shifting of distribution by applying environmental strategies, (c) compression of distribution at tail-end for high-risk drinkers by applying SBIRT strategies, and (d) compression and shifting by applying both SBIRT and environmental strategies. The dotted lines in (b), (c), and (d) represent the risk spectrum without intervention.

2. Agent Models as a Basis for Modeling Dynamics in College Drinking

2.1 Agent Definition and Transition Modeling

Agent-based models are powerful computational models for “exploring a set of behavioral assumptions required to generate a macro-pattern of explanatory interest” (Macy & Miller 2002). Here, we adapt an ABM related to alcohol consumption behavior, described in Gorman et al. (2006), for college drinking. Following setup, the ABM examines the interaction between three types of agents defined by their current drinking status—susceptible nondrinkers (S), current drinkers (D), and former drinkers (R).

Similar to ABMs for infectious diseases, this ABM specifies the probabilities of moving



from one drinking type to another as a function of the current system status. For example, the probability of a susceptible nondrinker at time t becoming a drinker at time $t + 1$ is determined by the status of the system at t and the value of a pre-

Figure 3. Agent model showing rules governing transitions between susceptible drinkers (S), current drinkers (D), and former drinkers (R).

specified parameter. Specifically, this probability is given by $\delta \times D(t) / C(t)$, where $D(t)$ is the number of current drinkers within the system at time t , $C(t) = S(t) + D(t) + R(t)$ is the sum of all three types of agents at time t , and δ is a parameter controlling the rate of conversion of a randomly selected susceptible nondrinker to a current drinker. Under the multiplicative model, the probabilities that S and R are drawn to D are both directly proportional to the number of drinkers - a proxy for the drinking culture of the school - in the system. Thus, the model assumes a social influence process. However, the respective rates (proportionality constants) of a nondrinker becoming a drinker and a former drinker becoming a drinker again are governed by different system parameters.

Figure 3 shows the rules governing the interaction and transition of the three types of agents. We first started with a system of 0 students and included every 12 months a class of college freshman into the system. The class of college seniors graduated and exited the system after 48 months. Each class was given a size of $N = 2,500$ so that the school at steady state had a total of $N = 10,000$ students. Note that the

way parameters governing the transition probabilities were specified was different from the original Gorman et al. (2006) model. Unlike the additive model in Gorman et al., the college drinking model depicted in Fig. 3 is multiplicative in the parameters and the proportions of D and R. The three parameters of interest are (1) the conduciveness parameter δ , which indicates how conducive the environment is to drinking and how it affects the rate of converting a susceptible nondrinking student to a current drinker; (2) the recovery parameter γ ; and (3) the relapse parameter ρ . The last two parameters, respectively, govern the rate of recovery from drinking to nondrinking status and the rate of relapsing into drinking status for recovered students.

2.2 Initial Conditions

Using 2010 data from the SPARC study, which indicated that 49.1% of high school students did not have a drink over the past 30 days, we assigned, for every class of freshmen entering the system, 49.1% of the students as susceptible (S). We also assigned 21.2% of the freshman class as current drinkers (D) and the remaining percentage as former drinkers (R). These percentages were based on an estimate using SPARC survey data from a question asking about college students' high school experience. At each iteration (month), a student was moved according to the rules of probability (Fig. 3). By definition, once a susceptible nondrinking student became a current drinker, the student could not move back to the susceptible category. The status of a student was updated every month. To initiate the system, many sets of parameter values for (δ, γ, ρ) were tested in the simulation experiment, and the respective steady-state results—specifically, the distribution of current drinkers across classes—were compared with the actual data from SPARC. The parameter values that produced the closest match to the observed distribution were used as a reference. Multiple scenarios were then evaluated by altering the values of the parameters and compared to the reference scenario. In order to explore long-term trends in system behavior, all simulation experiments were run for a period of 240 months.

2.3 Results

Scenario 1 (Reference Scenario)

The following set of parameter values was found to produce a close match to the observed SPARC 2010 data: ($\delta = 0.15, \gamma = 0.5, \rho = 0.4$). Table 1 compares the distribution of drinkers derived from the SPARC 2010 data and the simulation experiment (ABM). The percentages of drinkers from the ABM simulation were based on averages of the last month of each of the last 120 months in the simulation so that they represent steady-state values. Figure 4(a) shows the distribution of the three types of agents in the school over time for this scenario. Figure 5(a) shows the evolution of

	SPARC 2010	ABM
Freshman	59%	61%
Sophomore	66%	70%
Junior	71%	76%
Senior	84%	82%

Table 1. Proportion of drinkers across 4 classes SPARC 2012 data and simulated data (ABM).

the three types of drinkers of a cohort of students over 4 years of college. To avoid the initial start-up effect, we selected a “steady-state” cohort from the 12th year. The same cohort was selected for the other designed scenarios. Figures 4(a) and 5(a) both demonstrate that the

population attained a steady state rather quickly, and that, despite the incoming-class effect, which manifests itself as jigsaw-shaped patterns for S and R, the levels of the three types of agents were rather consistent, with S at approximately 30% (3,000/10,000) throughout. Not surprisingly, Fig. 5(a) shows that S declines quickly for the incoming cohort during the freshman year. However, the proportion of drinkers tends to be consistent after the freshman year (i.e., beyond 12 months).

Scenario 2: High Conduciveness

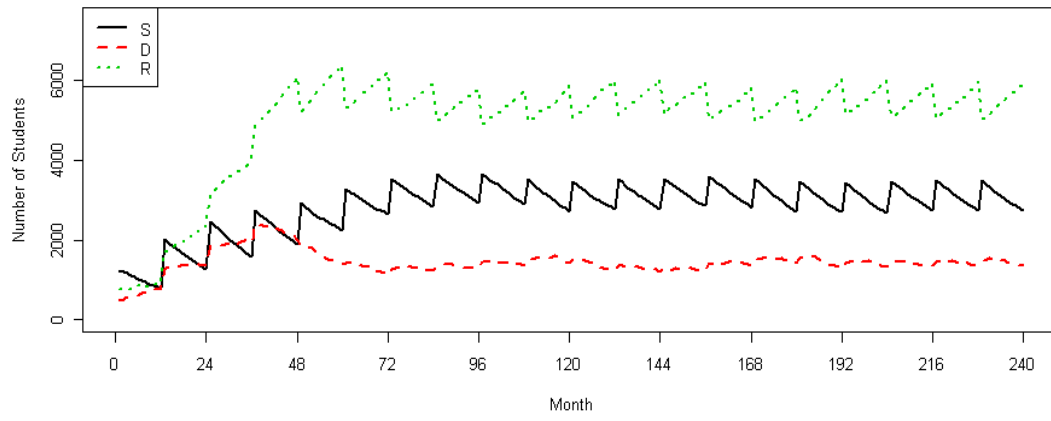
In this scenario, the recovery and relapse parameters were kept the same as in Scenario 1, and the conduciveness parameter was increased from 0.15 to 0.3. Thus, the parameters for Scenario 2 are specified by $\delta = 0.3, \gamma = 0.5, \rho = 0.4$. Figures 4(b) and 5(b) show, respectively, the evolution of the population and the 12th-year cohort in terms of the three types of drinkers. Surprisingly, although the increase in conduciveness of the environment tends to change the dynamic somewhat by decreasing the number of susceptible drinkers, it does not have a large impact on D (Fig. 4(b)). In other words, the number of current drinkers only goes up slightly higher but remains at a level comparable to that of Scenario 1. A closer examination of the dynamic reveals that the rate of transition from S to D does not have a large impact on the steady-state of the system; it is the cycling in-and-out of D and R that primarily determines the number of current drinkers eventually. Following the cohort in Fig. 5(b) confirms this pattern. The number of drinkers remains at approximately 500 (out of a total of 2,500) throughout the

48-month period. The increase in conduciveness reduces the number of S and increases the number of R.

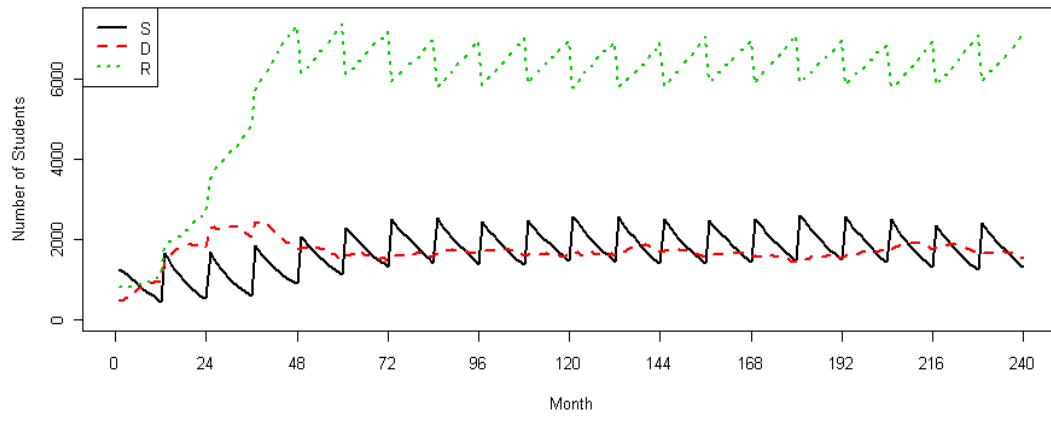
Scenario 3: High Relapse

Scenario 3 is characterized by a higher relapse rate. Compared with Scenario 1, the only change is the relapse parameter ρ —i.e., $\delta = 0.15, \gamma = 0.5, \rho = 0.5$. The small increase in the value of ρ from 0.4 to 0.5, it turns out, significantly affects the behavior of the system. Compared with the previous level of approximately 2,000 current drinkers in the population in Scenario 1, the higher relapse rate leads to a substantial increase in the number of drinkers—the number of drinkers triples to approximately 6,000 (Fig. 4(c)). The graph in Fig. 5(c) is consistent with this observation. The number of drinkers in the 12th-year cohort rises during the first 12 months (freshman year) and stays at approximately 1,800 (72%) thereafter. The number of former drinkers stays flat over the 4 years, whereas the number of susceptible drinkers plunges to zero toward the end of 48 months.

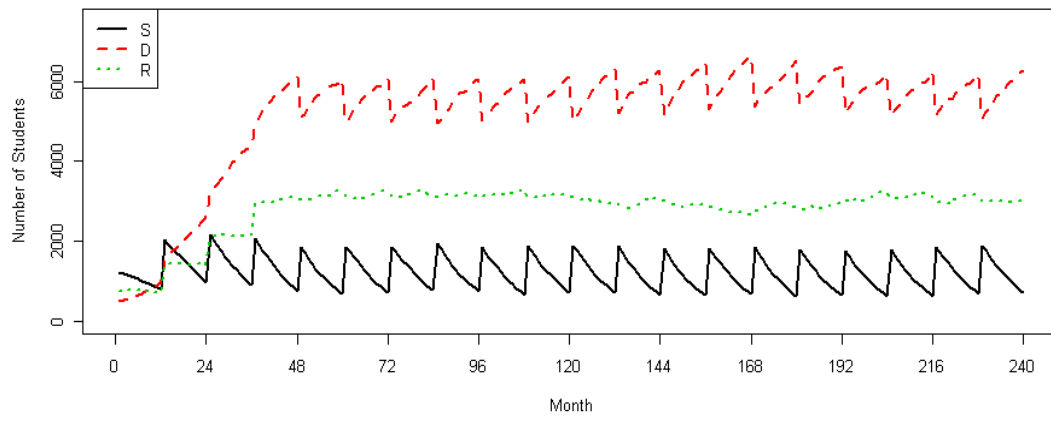
The findings in Scenario 3 are also consistent with what we observed in Scenario 2: that this system is more sensitive to the interaction between recovered and relapsed drinkers. The rate of conversion from susceptible nondrinkers to drinkers plays a relative minor role—most students eventually end up becoming drinkers at some point, and then the total number of current drinkers in the system transpires into a function of the recovery and relapse rates.



(a)



(b)



(c)

Fig. 4. The evolution of numbers of susceptible drinkers (S, solid line), current drinkers (D, dash), and former drinkers (R, dotted line). The conduciveness, recovery, and relapse parameters are, respectively, specified as (a) $\delta = 0.15, \gamma = 0.5, \rho = 0.4$, (b) $\delta = 0.3, \gamma = 0.5, \rho = 0.4$, and (c) $\delta = 0.15, \gamma = 0.5, \rho = 0.5$.

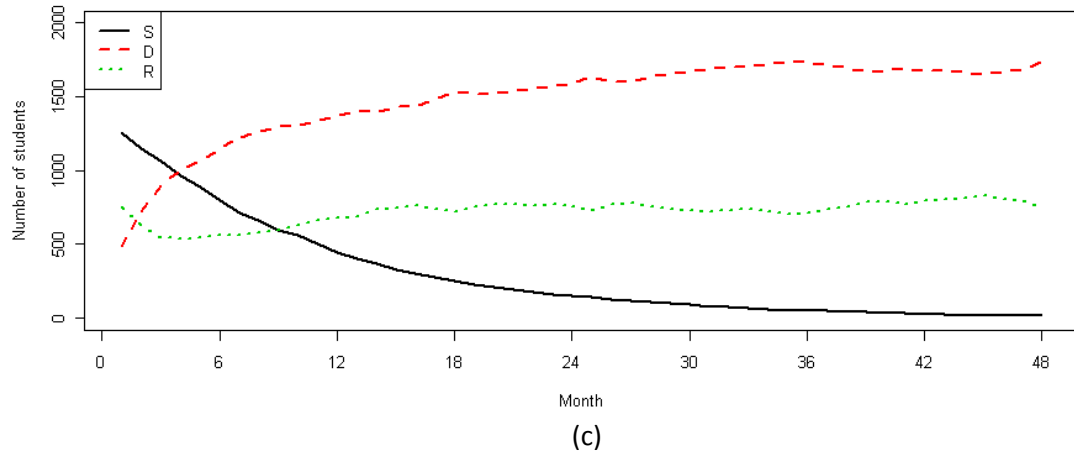
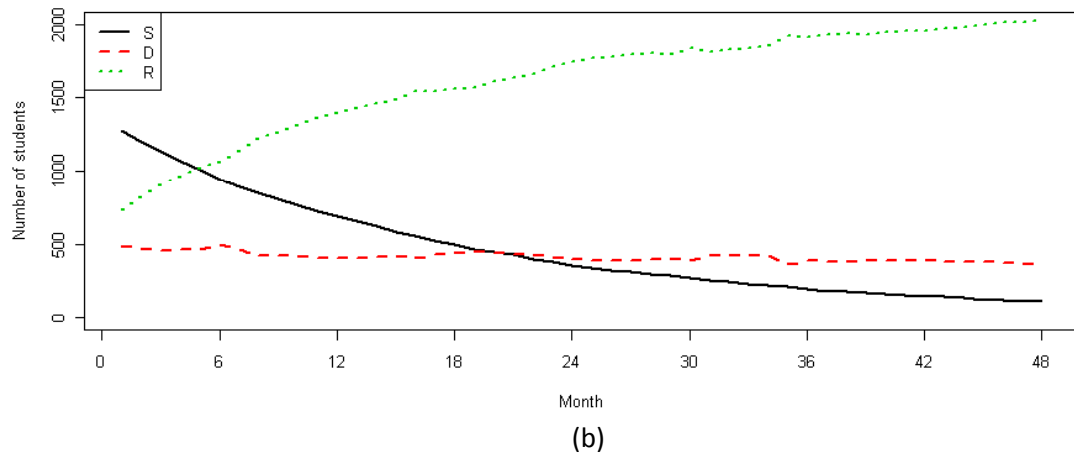
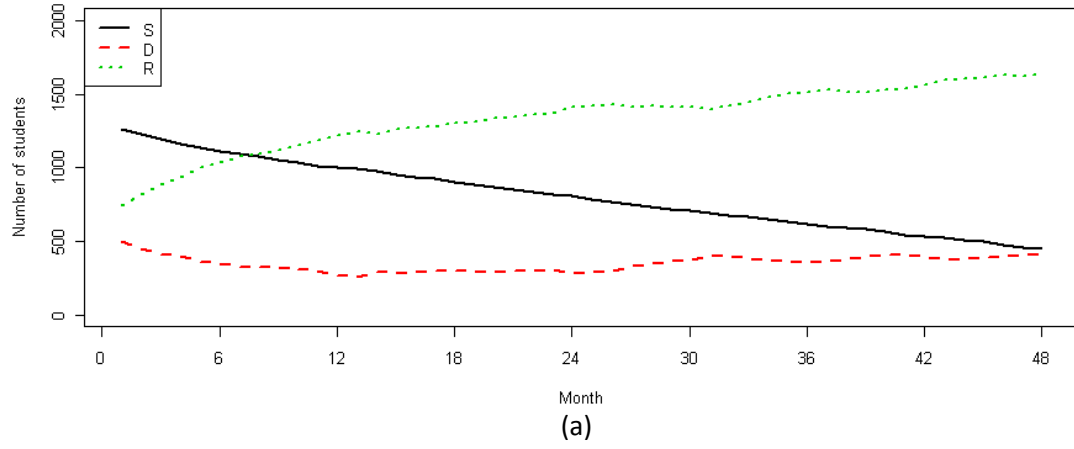


Fig. 5. The evolution of a cohort of students (total $N = 2,500$, from Year 12) categorized by drinking status (S, D, and R) through 4 years of college under 3 scenarios: (a) $\delta = 0.15, \gamma = 0.5, \rho = 0.4$, (b) $\delta = 0.3, \gamma = 0.5, \rho = 0.4$, and (c) $\delta = 0.15, \gamma = 0.5, \rho = 0.5$.

3. Delving Deeper into Feedback Mechanisms Using Causal-Loop Diagrams

Although it serves well as a tool for exploring the basic interaction between several types of agents, the simple ABM described above is rather preliminary and demonstrative in nature. While acknowledging the oversimplification of college drinking behavior, we would want to point out that the ABM can be further refined to include more system and individual features. For example, individual attributes such as personality traits, and spatial features such as geography and location of alcohol outlets, can be incorporated into the ABM. However, before creating a comprehensive model, it is important that we identify (1) individual and environmental factors that affect alcohol use in college, and (2) potential leverage points for actionable measures in reducing alcohol use in college, especially viewed from a system-science perspective.

To carefully examine the various factors affecting alcohol consumption in colleges and the potential leverage points for intervention, we use dynamic mapping, which is a technique for creating a detailed map of causal relationships between factors that affect the dynamics of a system. The causal mapping tools were based on system-dynamic (SD) (Sterman 2000; Forrester 1961). Recently, Zuashkiani et al. (2011) applied the SD toolbox to study the behavior of complex, dynamic socio-technical systems directly through the use of causal-loop diagrams (CLD). Specifically, they focused on mapping the dynamics of overall equipment effectiveness in the context of quality engineering. The CLD serves as a vehicle to visualize the dynamics of cause-and-effect relationships between components of a system. In the following two subsections, we introduce two respective causal loops—the individual-based biopsychosocial CLD and the environment-based, socio-ecological CLD. Furthermore, we identify potential leverage points for respective individual- and group-based SBIRT intervention and environmental intervention. This work is largely based on our previous work in the SPARC study, and also on our literature review.

3.1 Biopsychosocial Dynamic Model of Alcohol-Dependent (AD) Drinkers

The first CLD, which describes a biopsychosocial model of AD, shows the various factors affecting high-risk drinking and the plausible reinforcing loops (Figure 6). The biopsychosocial model is a general model of addictive behavior (Marlatt & VandenBos 1997) that views addiction as a complex behavior pattern having biological, psychological, social, and behavioral components. While most drinkers on college campuses consume alcohol for social and other reasons, there is still a significant percentage of AD students that can be classified as addictive to alcohol, using the criterion of score 13 or above for females and 15 or above for males on their Alcohol Use Disorders Identification Test (AUDIT) score (Babor et al. 2001). Using 2011 data from the SPARC study, the prevalence of AD drinkers was found to be approximately 8% overall, with a higher proportion in males (9.6%) than in females (7.0%). The

freshman class had a lower prevalence in AD (6.4%) as compared with the sophomore class (9.3%). As pointed out in the Introduction, this segment of the population would be likely to be resistant to policy changes and is deemed more responsive to SBIRT intervention.

Drawing from theories in the addiction literature (e.g., Altman 1996), we suggest three reinforcing loops for high-risk drinking in college. The three reinforcing loops are depicted in Fig. 6, respectively, for (1) biological changes occurring in the brain due to regular drug administration—in this case, alcohol (R1); (2) psychosocial changes due to positive reinforcers such as social approval (R2); and reinforcers such as drinking to relieve pressure from consequences of drinking (such as poor academic performance) (R3). The presence of environmental cues, such as alcohol advertisements and the general availability of alcohol products during parties and athletic events, and the presence of drinking peers, are depicted in Fig. 6 as contextual factors that could directly contribute to high-risk and AD drinking behavior. A self-regulation variable is included in the individual-based CLD to depict the effect of an individual's own control over high-risk drinking. Self-regulation has been described as a cognitive construct that allows for “planful action designed to change the course of one's behavior” (Miller & Brown 1991). SRT intervention strategies such as counseling can be used to improve self-control and self-regulation in reducing high-risk drinking, and this accordingly produces a counterbalancing causal loop (B1). Group or individual therapy—e.g., counseling and medication—can also be used to break the biological and psychological reinforcing loops R1 and R3.

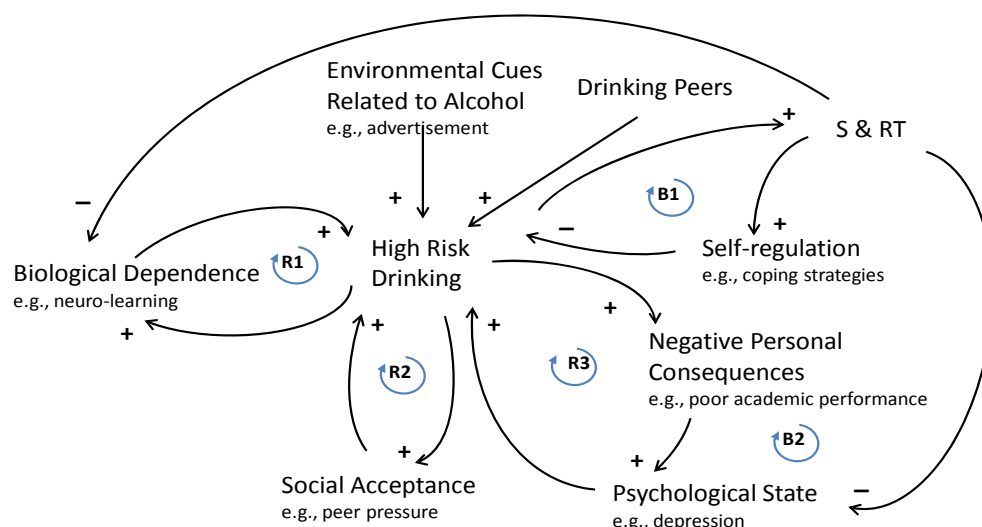


Fig. 6. Biopsychosocial model of AD and intervention strategies for high-risk and alcohol-dependent drinkers in college. S & RT stands for Screen, Referral to Treatment.

3.2 Culture-Based Dynamic Model for Alcohol Consumption

Whereas Fig. 6 shows an individual-based CLD of drinking among high-risk and AD drinkers, Fig. 7 depicts system-level causal relationships between multiple components of drivers that could affect the “drinking ecology” of a college campus. There are three important drivers of overall alcohol consumption: (1) the marketing of alcoholic products on campus, (2) the availability of alcoholic products on campus and in nearby neighborhoods, and (3) the school’s “culture” in accepting alcohol use as a social norm.

The marketing of alcoholic products includes advertisement at point-of-sale, in student newspapers and magazines targeting college students, merchandise, and marketing campaigns at sporting events. Easy access to alcohol is especially problematic in causing underage drinking. It was reported that one out of every four off-premise establishments near college campuses sold beer kegs (Kuo et al. 2003), which is the source of very-low-cost or free alcohol made available to underage drinkers at parties and other social events. For the third driver—culture—there are many aspects

for defining and describing the drinking culture at a school. For example, fraternity and sorority members have been identified as one of the key groups fostering a culture of drinking on campus (NIAAA 2002). How schools enforce alcohol-related policies is also an important component of school culture. The reinforcing causal loop R4 in Fig. 7 shows the effect of culture on alcohol consumption as well as the reinforcement of drinking culture by a prevalent and sustained level of alcohol consumption on campus. While results of different policy interventions on alcohol use in college have been mixed, schools do have a range of policy options to decrease alcohol use. These policies could target both general college students and underage college students. For example, compliance check, which entails an underage person attempting to purchase alcohol under the supervision of law enforcement and with penalties applied to the server/license holder, appeared to hold promise as a policy to reduce underage drinking (Scribner and Cohen 2001). Easy access to cheap/free alcohol is often an important attribute of schools that have a strong drinking culture. Decreasing commercial access to alcohol such as restricting or banning home delivery and limiting sales on campus, could also be effective in counterbalancing the positive culture-consumption feedback loop (B3). Indeed, Toomey, Lenk, & Wagenaar (2007) reviewed 110 alcohol-related studies published during the period 1999–2006, and they concluded that school environmental policies and strategies, whether they were implemented in isolation or in combination, were effective in reducing college drinking. Two comprehensive lists of specific policies—one for underage drinkers and one for general drinkers—were documented in their report. We do not repeat these specific strategies in the CLD but rather refer readers to that paper for the complete lists of environmental intervention strategies.

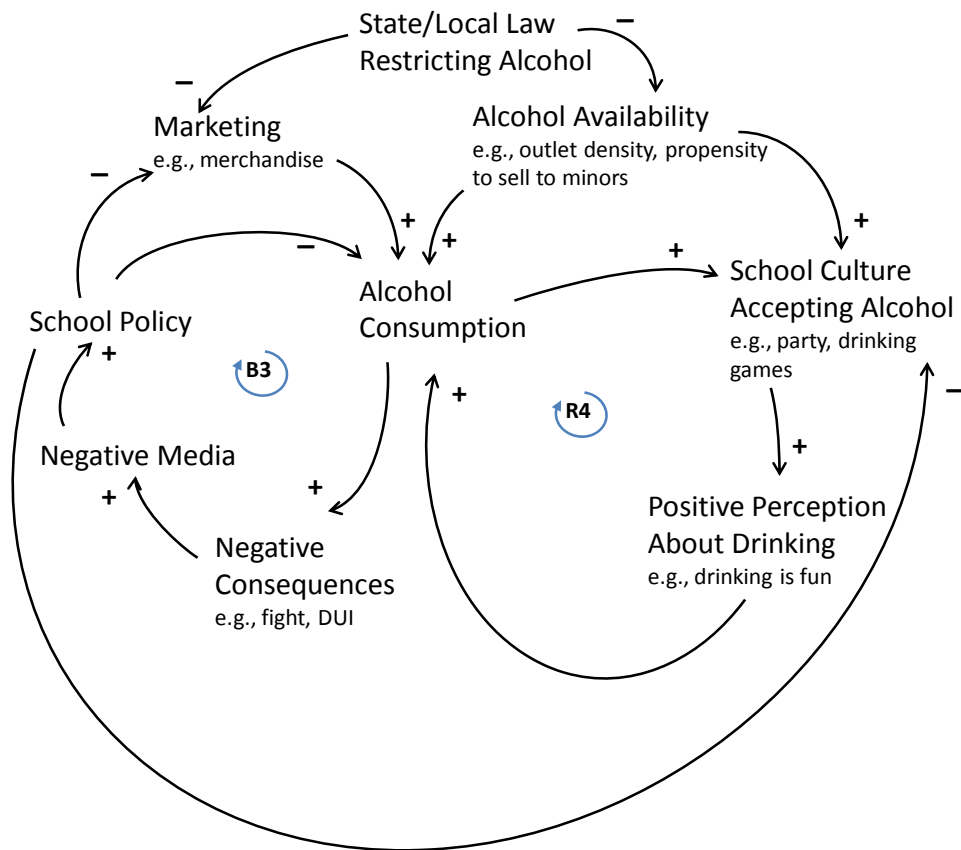


Fig. 7. Environmental intervention model targeting low- to medium-risk drinkers in college.

Discussion

In this paper, we describe a basic agent model for exploring the dynamics of college drinking as well as system dynamic maps for identifying leverage points for applying intervention strategies. We focus on two different strategies that target, respectively, (1) high-risk and AD drinkers and low- to medium-risk drinkers, which is the SBIRT approach that emphasizes screening and individualized therapy, and (2) the environmental approach that emphasizes school policies and local law. This study serves as a precursor to a further study for developing a more comprehensive SD model for college drinking behavior and intervention. We hope that subsequently the SD model can be operationalized and calibrated for informing a subsequent ABM of refined, simulated agent-level behaviors.

The preliminary ABM model, while relatively simple in terms of interaction between agents, does offer interesting insight into college drinking behavior. For example, the ABM suggests that for high school students entering college the conversion rate of susceptible nondrinkers to drinkers may not be as important as other control parameters during their four years of stay. The total number of drinkers coming out of college tends to quickly stabilize, and the level is more sensitive to relapse and recovery rates of drinkers on campus. If this is true, then it has important policy implications because more resources should then be invested in increasing recovery and decreasing relapse rates. Screening for alcohol use, for example, will be critical in identifying at-risk individuals and thus needs to be extensively conducted on a large scale on campuses. Currently, screening for alcohol use is at best haphazard and varies greatly across campuses. Using data from the SPARC study, we found that for students who went to see school health providers, only 39.8% were asked whether alcohol was used. Of those who were asked, two-thirds were not given a recommendation for reduction of alcohol use. Clearly, more work will be needed for screening.

An important strength of the current study is the delineation of the two broad strategies for targeting the entire risk spectrum of drinkers in order to design appropriate system-dynamic models. Distinguishing between low- and medium-risk drinkers and high-risk and AD drinkers could, however, give rise to challenging methodological and modeling issues. For example, how does one evaluate the overall effects by simultaneously implementing a mix of both strategies? Could the combined strategies produce synergistic effects? How could a policy maker answer “what-if” questions concerning different schemes of allocating resources for reducing alcohol consumption? Currently, there is little information about the potential effect of a hybrid approach. The SD/ABM approach could be an important tool to help answer some of the critical questions regarding policy intervention.

There are limitations to this study. First, the ABM does not contain location and personal attributes. The probabilistic model assumes that the behaviors of agents are

homogeneous. While there is interaction between the agents, important factors affecting agent interaction, such as within on- or off-campus drinking facilities, are not taken into account. In this paper we only examine aggregate behaviors at the population level. In the future, we plan to refine the basic model and exploit the distinctive capacities of ABM, namely, to include (1) personal characteristics such as risk level of drinking, gender, and other social and demographic characteristics, and (2) interaction with other agents within a local social context such as bar and fraternity. A second limitation of the paper is that the SD model in its current form still requires extensive work to make it meaningful for policy makers. For example, quantitative data will be required for successful calibration and validation. Currently, work is in progress in this direction.

The consequences of high-risk drinking and the prolific use of alcohol among college students are staggering. This includes 1,700 unintentional alcohol-related fatalities, half a million unintentional non-fatal injuries, and 97,000 sexual assaults annually (NIAAA 2002). System-dynamic and agent-based models are powerful tools to help researchers and policy makers understand college drinking as a complex behavior that is driven by biopsychosocial, environmental, and cultural factors. This paper is an attempt to move our understanding in this potentially rewarding direction.

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