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ORIGINAL ARTICLE

A Differential Equation Model for the Dynamics of Youth Gambling

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Abstract

Objectives: We examine the dynamics of gambling among young people aged 16—24 years, how prevalence rates of at-risk gambling and problem gambling change as adolescents enter young adulthood, and prevention and control strategies.

Methods: A simple epidemiological model is created using ordinary nonlinear differential equations, and a threshold condition that spreads gambling is identified through stability analysis. We estimate all the model parameters using a longitudinal prevalence study by Winters, Stinchfield, and Botzet to run numerical simulations. Parameters to which the system is most sensitive are isolated using sensitivity analysis.

Results: Problem gambling is endemic among young people, with a steady prevalence of approximately 4—5%. The prevalence of problem gambling is lower in young adults aged 18—24 years than in adolescents aged 16—18 years. At-risk gambling among young adults has increased. The parameters to which the system is most sensitive correspond to primary prevention.

Conclusion: Prevention and control strategies for gambling should involve school education. A mathematical model that includes the effect of early exposure to gambling would be helpful if a longitudinal study can provide data in the future.

1. Introduction

The combination of intensely curious young minds, risk-taking behaviors, sensitivity to peer pressure, increased opportunities for gambling, and the excitement induced by games of chance can be harmful to teenagers and young adults. Considering the effects of excessive gambling on adolescent and young-adult development and the rapid expansion of the legal gambling market, many sociologists and psychologists have studied youth gambling behaviors for the last 20 years or so. However, to the best of our knowledge, no mathematical modeling approach has been used to study the dynamics of youth gambling.

Gambling is betting on an uncertain outcome. Youth gambling occurs in many forms, from simple board games to betting on sports to casino games. Adolescents have little difficulty in accessing games that are

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supposed to be restricted to adults [1]. According to the 2007 Minnesota Student Survey (MSS), the highest underage (≤17 years of age) participation in gambling among Minnesota public school students was observed for lottery gambling [2]. Jacobs reported that lottery play dominates legalized forms of gambling among juveniles in both the United States and Canada [3]. According to Wilber and Potenza, actual rates of participation depend on the accessibility of gambling opportunities and the types of gambling available [4]. Youth gambling involves lower amounts of money and lower frequency, but more strategic forms of gambling than adult gambling. When adolescents become young adults, circumstances change. They are no longer underage gamblers, they have a job, and they have less free time, but they have more money. Does this situation change the rate of prevalence of problem gambling?

Almost all young people try gambling at some time because legalized gambling is well accepted in society and is harmless for most young people, but it begins to cause problems for some individuals as the frequency of their gambling increases. Gambling occurs on a frequency continuum, ranging from experimenting, occasional gambling, and regular gambling, to preoccupation, which has serious adverse consequences [5]. The instruments most commonly used to measure the severity of gambling problems for adults are the South Oaks Gambling Screen (SOGS) [6] and the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (DSM-IV) [7]. Revised versions of these tools for adolescents are the South Oaks Gambling Screen-Revised for Adolescents (SOGS-RA) [8] and the Diagnostic and Statistical Manual of Mental Disorders, fourth edition, Multiple Response - Adapted for Juveniles (DSM-IV-MR-J) [9]. Excessive gambling is identified according to the scores or criteria of each specific instrument,. For example, at-risk gambling and problem gambling are defined as a score of 2 or 3 and a score of 4 or above, respectively, on the SOGS-RA/SOGS [10, 11]. Prevalence rates vary depending on the survey methods, instruments, and the geographic areas involved, as well as the source of research funding. Data for New York State indicate that approximately 10% of adolescents are problem gamblers and another 10% are at-risk gamblers [12]. For Nevada, the prevalence estimated for problem gambling and at-risk gambling among adolescents is 2.2% and 9.9%, respectively [13]. Shaffer and Hall estimated that the prevalence of problem gambling among adolescents in the USA and Canada was between 4.4% and 7.4% [14]. Winters et al. used three age categories of 16, 18, and 24 years for Minnesota and found prevalence rates of 2.3%, 4.3%, and 3.9% for problem gambling, and 14.8%, 12.1%, and 21%, respectively, for at-risk gambling [11]. Jacobs used nine US youth gambling surveys from 1989 to 2002 and found an average rate of 3.7% for problem gambling [15]. Welte et al. carried out nationals survey of 2274 young people aged 14—21 years in 2005 and 2007 and calculated a prevalence of 2.1% for problem gambling [16]. LaBrie et al. conducted a large national survey of 10,765 students attending 119 scientifically selected colleges, and found that 2.6% gambled weekly or more frequently [17]. Most of these studies have found that prevalence rates of problem gambling among young people have been stable. However, Winters et al. warned that at-risk gambling increases as adolescents mature to young adulthood [11].

Many studies agree that gambling is viewed by adolescents as an opportunity to socialize [3, 4,18—20]. According to Wilber and Potenza, “Peers may introduce others to gambling as a shared social activity. [4]. Peer group gambling, susceptibility to peer pressure, and having peers who gamble, especially peers who gamble excessively, are significant risk factors for excessive gambling [3, 4, 19]. Excessive gambling is accompanied by associated problems, so old friends are replaced by fellow gamblers, bookmakers, and loan sharks [18]. Shaffer and Korn viewed problems associated with gambling as a socially transmitted disease and used the classic public health model for communicable disease [21]. They treated exposure to gambling or activities that promote it as a sequence of social contacts that conceptually act like contagious germs that can lead to adverse health consequences, in this case, problem gambling. Some sociologists have found that certain social phenomena, such as early sexual behavior and juvenile delinquency, are contagious [22—25]. A significant predictor of the occurrence of these phenomena is peer pressure in the sense that the occurrence depends on the number of individuals who are and who might be involved, as well as the frequency, duration, priority, and intensity of association with peers. As a society we have changed our view on gambling because of socially transmitted acceptance of gambling, and allow ourselves to participate in games of chance. Lee and Do studied the dynamics of gambling among older adults using this approach [26].

In the present study, we used a mathematical modeling approach to investigate the dynamics of gambling among young people by creating a simple epidemiological model. We assume that young people are introduced to gambling by a peer, that gambling activities increase when people around them gamble a lot, and that more gambling opportunities are provided. By treating excessive gambling as a socially transmitted disease, environmental peer contagion is expressed using the mass action terms applied in epidemiological models. Our model consists of three classes. To specify the rates at which individuals move from one class to another, the reasons underlying such transitions are discussed. The model seeks to examine the dynamics of the system via stability analysis and a basic reproductive number. The 2005 study by Winters et al. contains a rare longitudinal set of data [27]. We apply our model to