# The Importance of Smoking Definitions for the Study of Adolescent Smoking Behavior

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***Purpose.*** Smoking is the leading cause of death and smoking initiation rarely occurs after adolescence. Thus research on adolescent smoking is crucial. A consistent definition of smoking is important because inconsistent definitions make comparisons across studies an arduous task. Thus, the aim of the study was to suggest future research directions for smoking definitions after examining pitfalls in the literature.

***Methods.*** In this study the literature on adolescent smoking in the U.S. and South Korea was examined, and three types of smoking definitions were identified. Limitations in the studies are identified and future research directions are suggested.

***Results.*** In the U.S. literature, smoking definitions can be categorized into three groups: definitions based on stage models, smoking trajectories, and definitions derived from specific data. In the South Korean literature, various levels of smoking have not been differentiated.

***Conclusions.*** While the literature does not provide a definitive answer regarding the definition of smoking, it suggests three issues to consider for future research. First, multiple measures of smoking are more desirable than a one-time measure. Second, theory- or trajectory-based smoking definitions are more desirable than definitions derived from available data. Finally, regularity and amount of cigarette use should be incorporated in defining smoking behavior.

**Key Words :** Smoking, Adolescent, Research Design

## INTRODUCTION

Smoking is the leading cause of death (Center for Disease Control and Prevention, 2002), and the detrimental effects of smoking on health, such as bronchitis, asthma, and cancer are well known (Arday et al., 1995). In addition, economic loss linked to smoking-related health issues among adults accounted for 8% of personal health care expenditures in 1998 (CDC, 2002). Because of attempts to reduce the smoking rate, adult smoking has been significantly decreased in the United States. Compared to adult smoking, however, adolescent smoking has not declined, and remains a major public health concern (CDC, 2004). Also, the South Korean government has attended to smoking behavior because South Korea ranked first worldwide for the rate of male adult smoking, and the rate of adolescent smoking has been on the rise since the 1980's (Yonsei University School of Public Health, 2005).

Since smoking initiation rarely begins after adolescence and once smoking begins it is difficult to stop smoking, adolescent smoking is a critical matter (Johnston, O'Malley, & Bachman, 2001). Researchers have attempted to discover critical factors affecting adolescent smoking, and a substantial amount of empirical evidence has improved the understanding of this phenomenon. Despite this important contribution, a signifi-

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cant methodological issue remains unanswered in the literature. Most studies have used different definitions of smoking, which have often made it difficult to compare findings across studies. Currently, definitions used in the literature are categorized into three groups, definitions based on stage models, smoking trajectories, and definitions derived from specific study data. Among these three categories, definitions of smoking based on survey questions without any theoretical or empirical consideration are problematic because they lead to confusing findings. Despite this limitation, this type of definition has been widely used. For instance, the definitions of current smoking in the three U.S. national surveys are not consistent. In these studies, current smoking has been defined as the frequency of smoking during the past 30 days, the number of days that the subjects smoked during the past 30 days, the use of 100 cigarettes in a subject's life, or at least part or all of a cigarette during the past 30 days (National Center for Health Statistics, n.d.).

The purpose of this study was to review the literature relative to adolescent smoking and the definitions used, and to propose future research directions in order to enhance the rigor of research on smoking behavior. The literature review is divided into two parts, U.S. studies and South Korean studies. In the U.S. literature, stages defined by theoretical models are examined, followed by trajectories empirically defined by study populations (i.e. categorizing into several homogeneous groups based on a change in subjects' smoking behavior over time). In the South Korean literature, smoking definitions are reviewed among studies representative of adolescents nationally or provincially.

## Smoking Definitions in the U.S. literature

### *Stage Models*

In stage models, change in smoking is considered a stage process rather than a continuous process (Hirschman, Leventhal, & Glynn, 1984). Stage models can be further categorized into three groups: (a) models that emphasize behavioral stages of smoking, (b) models that emphasize motivational stages of smoking, and (c) models that combine several of these into one (Table 1).

In three studies stage models were examined from a behavioral perspective (Flay, D'Averns, Best, Kersell, & Ryzn, 1983; Kremers, Mudde, & de Vries, 2004a; Leventhal & Cleary, 1980). Leventhal and Cleary (1980)

proposed that once a person becomes a smoker, he/she goes through a series of processes: preparation, initiation, and maintenance of smoking. Flay and colleagues (1983) elaborated on the stage model of Leventhal and Cleary (1980), suggesting five stages: preparation (formation of knowledge and beliefs about smoking), initial trial (the first two or three tries), experimentation (repeated but irregular cigarette use), regular use (e.g., smoking every weekend or every day), and nicotine dependence or addiction (the development of internal need for nicotine). Whether initial triers make the transition to the next stages depends on their physiological reaction to smoking and psychological reinforcement (e.g., change in mood such as relaxation). Flay (1993) considered this process as stochastic, which means that the probability to progress to higher stages is always less than one. Kremers and colleagues (2004a) modified and expanded the stage model of Flay and colleagues (1983), and proposed a six stage model that excluded nicotine dependence and added non-smoking deciders (i.e., non-persistent triers and experimenters) and quitters (ex-regular smokers).

Contrary to the above studies that emphasized a behavioral perspective, the transtheoretical model stresses motivation in the progression to upper levels of smoking (Pierce, Choi, Gilpin, Farkas, & Merritt, 1996; Prochaska & DiClemete, 1983). The transtheoretical model has been used as a guide for behavioral change for health promotion such as smoking cessation, but has recently been applied in studies of smoking initiation. In this model, four stages of smoking are defined: (a) precontemplation (i.e., not intending to smoke in the future), (b) contemplation (i.e., intending to smoke in the future), (c) preparation (i.e., intending to smoke in the immediate future), and (d) acquisition (i.e., initiating occasional or regular smoking). People who are at the stage of contemplation are at a greater risk of smoking initiation than those who are at the stage of precontemplation (Pallonen, Prochaska, Velicer, Prokhorov, & Smith, 1998). In predicting the progression to a higher level of smoking, Pierce and colleagues (1996) tested the validity of susceptibility to smoking, which means the importance of situational components (a cigarette offer by a friend) and the intention to smoke among non-smokers, in predicting smoking initiation. The researchers concluded that those who do not have a firm commitment (susceptible to smoking) were at greater risk of initiating smoking than those who have a firm commitment not to

smoke in the future (non-susceptible to smoking).

Another motivational model for a sample of adolescent non-smokers has four stages (Kremers, de Vries, Mudde, & Candel, 2004). These researchers considered that people at the stage of precontemplation were not homogeneous and could be divided into three groups: (a) committers (sure to never start smoking), (b) immotives (not planning to start within the next 5 years), and (c) progressives (planning to start within the next 5 years, but not within the next 6 months). The fourth stage of this model is contemplators who plan to start

smoking within the next 6 months. Kremers and colleagues (2004) demonstrated that the odds of regular smoking increased as non-smokers progressed to higher motivational stages in the model.

Additionally, attempts were made to incorporate several stage models into one model in order to increase predictability of smoking behavior. Prokhorov and colleagues (2002) modified the transtheoretical model using susceptibility to smoking to predict adolescent smoking initiation, and created four stages of smoking: (a) non-susceptible precontemplation, (b) susceptible precontem-

**Table 1.** Stage Models

| Emphasized Theories | Author and Year of Publication | Smoking Categories |
|---|---|---|
| Behavioral stages | Leventhal et al. (1980) | Preparation<br>Initiation<br>Becoming a smoker<br>Maintaining smoking |
|  | Flay et al. (1983) | Preparation<br>Initial trial<br>Experimentation<br>Regular use<br>Nicotine dependence/Addiction |
|  | Kremers et al. (2004a) | Preparation<br>Initial trial<br>Experimentation<br>Regular use<br>Non-smoking deciders<br>Quitters |
| Motivational stages | Pallonen et al. (1998) | Precontemplation<br>Contemplation<br>Preparation<br>Acquisition |
|  | Kremers et al. (2004) | Committers<br>Immotives<br>Progressives<br>Contemplators |
| Combining several theories | Prokhorov et al. (2002) | Non-susceptible precontemplation<br>Susceptible precontemplation<br>Contemplation<br>Preparation |
|  | Kremers et al. (2004b) | Committed never smokers<br>Immotive never smokers<br>Immotive triers<br>Immotive experimenter<br>Contemplating experimenter<br>Immotive non-smoking decider<br>Committed non-smoking decider |
|  | Sun et al. (2005) | Non-susceptible non-smokers<br>Non-susceptible experimenters<br>Susceptible experimenters<br>Light smokers<br>Committed heavy smokers |

plation, (c) contemplation, and (d) preparation. The model proposed by Prokhorov et al. (2002) mainly focused on two motivational stage models. Other researchers, however, have highlighted the necessity of a wide range of stages from smoking initiation to addiction in order to understand adolescent smoking (Sun, Unger, & Sussman, 2005; Werch & Anzalone, 1995).

Kremers et al. (2004a) developed a seven stage model based on both behavioral and motivational stages of smoking, emphasizing the stage of smoking initiation: (a) committed never smokers, (b) immotive never smokers, (c) immotive triers, (d) immotive experimenters, (e) contemplating experimenters (those who are intending to smoke in the future), (f) immotive non-smoking deciders (triers or experimenters who stopped smoking), and (g) committed non-smoking deciders. In this model, it is assumed that smoking initiation occurs when adolescents move from the committed state (commitment not to smoke) to the immotive state (no commitment not to smoke). Contemplating experimenters can move either back to the immotive stage or forward to regular smoking. Despite the fact that the stage model of Kremers and colleagues (2004b) incorporated the stages from smoking initiation to regular smoking, this model did not differentiate stages of advanced smoking (e.g., daily smoking and addiction). In addition, Sun and colleagues (2005) developed five stages of smoking progression: (a) non-susceptible non-smokers, (b) non-susceptible experimenters, (c) susceptible experimenters, (d) light smokers, and (e) committed heavy smokers. These stages of smoking were determined based on whether people had ever tried cigarettes, how much tobacco per month they consumed, and whether they had an intention to smoke in the future.

The review of smoking definitions in the U.S literature suggests three categories of smoking definitions, and the current literature has not reached a consensus on which definition is the best. Despite no consensus on the most appropriate stage model, one important issue to note is that definitions based on stage models are more preferable than those derived from empirical data since these definitions are at least based on a conceptual underpinning. In addition, it can be useful for researchers to consider their study aims when they decide which stage models to use for a definition of smoking. For example, if researchers are interested in factors that cause smoking initiation, motivational stages can be more useful and informative; if, however, researchers are interested in factors that cause a higher level of smoking after smoking begins, behavioral stages can be more relevant.

### Smoking Trajectories

In smoking trajectories, adolescent smoking behavior is understood from a developmental perspective over time (i.e., a continuum rather than a stage process). Researchers who support the use of smoking trajectories consider that there are interpersonal differences in the timing of smoking initiation and changes in smoking behavior. Thus, they suggest that defining arbitrary stages of smoking is neither appropriate nor effective, and that understanding smoking trajectories is more helpful in reducing adolescent smoking (Audrain-McGovern et al., 2004). To define different smoking trajectories, researchers measure smoking behavior at multiple points in time and divide subjects into several groups based on homogeneous changes in smoking over time.

Six studies examined smoking trajectories during adolescence. First, Colder and colleagues (2001) examined changes in smoking behavior in a cohort of 6th or 7th graders until they became 10th or 11th graders. Using six measures of smoking behavior over the study period, they identified five smoking trajectories based on the levels of smoking, the point which transition to higher levels of smoking takes place, and the rate of transition: (a) early rapid escalators, (b) late moderate escalators, (c) late slow escalators, (d) stable light smokers, and (e) stable puffers. Those who were consistently non-smokers during six measurements were excluded from the sample in this study. For early rapid smokers, inflection in the rate of change in smoking happened before the first measurement of smoking. For late moderate and slow escalators, inflection in the rate of change in smoking occurred at ages 13 and 15, respectively. For the last two trajectory groups, the level of smoking was stable. Results revealed that before age 13, experimentation with smoking was typical, and that after age 13, different smoking patterns emerged: (a) adolescents stayed at lower stages of smoking and (b) adolescents moved on to higher stages of smoking either slowly or rapidly. Second, Soldz and Cui (2002) identified six smoking trajectories among adolescents followed from 6th to 12th grades: (a) non-smokers, (b) quitters, (c) experimenters (those who did not smoke for the first 3 years of the study and steadily increased levels of smoking), (d) early escalators (those who showed a sharp increase in smoking at Grade 8), (e) late escalators (those who sharply in-

creased the amount of smoking 4 years after the beginning of the study), and (f) continuous smokers. Continuous smokers were those who smoked at least a half a pack per month at grade 6, whereas those who belonged to the other five trajectories either did not smoke or only experimented with smoking at grade 6. The re-

**Table 2.** Smoking Trajectories

| Author and Year of Publication | Sample Characteristics | Follow-up Period | Defined Smoking Trajectories |
|---|---|---|---|
| Chassin et al. (2000) | 6th-12th graders at the entry of the study<br>Exclusion of non-smokers | 14 years | Early stable smokers<br>Experimenters<br>Quitters<br>Late onset smokers |
| White et al. (2000) | A cohort of 12 year old subjects | 18 years | Heavy/regular smokers<br>Occasional/maturing out smokers<br>Non/experimental smokers |
| Colder et al. (2001) | A cohort of 6th or 7th subjects<br>Exclusion of non-smokers | 4 years | Early rapid escalators<br>Late moderate escalators<br>Late slow escalators<br>Stable light smokers<br>Stable puffers |
| Soldz and Cui (2002) | A cohort of 6th graders<br>Inclusion of non-smokers | 7 years | Non-smokers<br>Quitters<br>Experimenters<br>Early escalators<br>Late escalators<br>Continuous smokers |
| Audrain et al. (2003) | A cohort of 9th graders | 3 years | Never smokers<br>Experimenters<br>Late adopters<br>Early adopters |
| Stanton et al. (2004) | A cohort of 9 year old children<br>Exclusion of non-smokers | 10 years | Early rapid escalators<br>Late rapid escalators<br>Late moderate escalators<br>Late slow escalators<br>Stable puffers<br>Late slow escalators |
| Abroms et al. (2005) | A cohort of 6th graders<br>Inclusion of non-smokers | 4 years | Never smokers<br>Intenders<br>Delayed escalators<br>Early experimenters<br>Early users |
| Karp et al. (2005) | A cohort of 7th graders<br>Inclusion of non-smokers | 3.5 years | Class I:<br>Staying at a low level of cigarette consumption over time<br>Class II:<br>Consuming a few cigarettes at the beginning and exponentially increasing cigarette use over time<br>Class III:<br>Consuming a few cigarettes at the beginning, reaching the highest level of consumption 2 years after smoking onset, and afterwards decreasing cigarette consumption<br>Class IV:<br>Consuming relatively many cigarettes at the beginning and maintaining a higher level of cigarette consumption than the other three classes |

maining research on adolescents suggests similar smoking trajectories to the above studies. In general, smoking trajectories in the literature can be categorized into five groups: (a) non-smokers, (b) early escalators, (c) late escalators, (d) experimenters, and (e) quitters (Abroms, Simons-Morton, Haynie, & Chen, 2005; Audrain, Rodriguez, & Moss, 2003; Karp, O'Loughlin, Paradis, Hanley, & Difranza, 2005; Stanton, Flay, Colder, & Mehta, 2004) (Table 2).

Two other research groups investigated smoking trajectories over time, and in these studies, subjects were followed over a longer period from adolescence to young adulthood (Chassin, Presson, Pitts, & Sherman, 2000; White, Pandina, & Chen, 2002). Chassin and colleagues (2000) determined four subgroups of smoking behavior with three measurements of smoking behavior across 14 years: (a) early stable smokers who started smoking in adolescence and kept smoking until the end of the study, (b) experimenters who did not go on to higher levels of smoking, (c) quitters who stopped smoking after regular smoking, and (d) late onset smokers who began regular smoking in young adulthood. In another study by White and colleagues (2002), five measures of smoking behavior across 18 years were used, and three trajectory groups were identified: (a) heavy/regular smokers, (b) occasional/maturing out smokers, and (c) non/experimental smokers. Heavy/regular smokers are those who increased cigarette consumption and maintained a high level of smoking over the study period. Occasional/maturing out smokers are those who increased cigarette consumption until age 18, and afterwards decreased their level of cigarette use. Non/experimental smokers are those who remained at a low level of smoking throughout the study period.

In understanding adolescent smoking behavior, smoking trajectories are persuasive because smoking-trajectory studies acknowledge distinct differences in the development of smoking relative to the timing and intensity of progression, which allows researchers to examine heterogeneity of smokers and divide subjects into homogeneous groups. The determination of homogeneous smoking groups makes it much easier to predict and intervene in smoking behavior among young people (Audrain et al., 2003). In spite of the above merits, it should be noted that only a small number of empirical studies on smoking trajectories are available in the literature and that studies have used a different follow-up period, different smoking measures, and different charac-

teristics of the sample (e.g., whether or not the sample included non-smokers) (Abroms et al., 2005). Thus, it is necessary to conduct more studies to see if findings regarding smoking trajectories are replicated.

## Smoking Definitions in the South Korean Literature

South Korean researchers have explored a wide range of factors that affect adolescent smoking. A limitation in the literature is that the majority of studies have used a cross-sectional design to examine an association between smoking and factors of interest. Although a cross-sectional design provides a relationship between smoking and potential factors, a causal association cannot be determined using this research design. Currently, three nationwide studies of adolescent smoking behavior are available in South Korea. Since 1988, Yonsei University and the Korean Association of Smoking and Health have explored smoking behavior among middle and high school students annually or biannually, and findings in this study have been used as national statistics (Korean National Statistical Office, 2005). In this study, smoking behavior has been examined with a question about smoking history and frequency, and current smokers were defined as those who reported cigarette use at the time of survey regardless of levels of smoking. In this study, never smokers could be differentiated from current smokers, but different smoking patterns among current smokers could not be examined because this study did not explore the detailed frequency and regularity of cigarette use.

Second, the Korean National Tuberculosis Association explored smoking behavior among adolescents representative of South Korean middle school students. In this study, two types of smokers were defined: (a) those who had tried cigarettes, at least a few puffs, and (b) those who smoked regularly at the time of the survey (Cheong, 2003). In the study, regularity of smoking was determined subjectively by the subjects' perception of their smoking behavior, and thus the validity and reliability of smoking measures could not be guaranteed. Furthermore, information on the different levels of smoking was not available in the data.

The final nationwide study is the Korean Youth Panel Survey (KYPS), which has examined adolescent smoking behavior longitudinally. While this study is important in that it was possible to explore a causal effect of factors

on smoking, the questionnaires regarding smoking behavior in the KYPS were not thorough enough to determine different levels of adolescent smoking. In this study, the researchers asked the subjects who smoked at the time of the survey, to choose if they were either experimenters (i.e., 2- or 3-time cigarette users) or regular smokers. Thus, levels of smoking (experimenters and regular smokers) were determined subjectively rather than objectively. With respect to their smoking frequency, experimenters provided smoking frequency during the past year; regular smokers provided information on smoking frequency per day (Korean Institute for Youth Development, 2004).

In addition to the three national studies, there were two studies conducted at the provincial level. Park (2005) explored smoking behavior in the Daegu area (Kyung San Province). Definitions of smoking behavior in this study were based on the CDC's definition. Current smokers were those who smoked during 30 days prior to the survey, and lifetime smokers were those who smoked at least a few puffs in their lives. Lee and Moon (2003) explored smoking behavior in a rural area of South Korea. This study had an attribute different from other studies. Subjects provided information on their intention to quit smoking. Current smokers were defined as those who used cigarettes at the time of the study regardless of their intention to stop smoking.

In sum, the above studies representing South Korean adolescents, either nationally or provincially, have not contributed to understanding diverse patterns of adolescent smoking in reality. This can be attributable to partial use of available information and a lack of a theoretical foundation in smoking definitions. Further, the studies have overemphasized current smoking, which consists of heterogeneous smokers. These studies failed to capture complicated smoking behavior among adolescents by only examining current smoking rather than different types of smoking. Although current smoking is a concern, the transition to higher levels of smoking is also noteworthy, considering that a substantial portion of Korean adolescents are current smokers and that a higher level of smoking is associated with a greater risk of experiencing negative health outcomes.

## Directions for Future Research on Smoking

Defining smoking behavior is a stepping stone in research on smoking. In order to find influential factors, smoking behavior should be defined clearly at the beginning stage of research. In addition, the choice of either a cross-sectional or a longitudinal design is critical. A cross-sectional design is not likely to capture change in smoking behavior since smoking behavior and other factors are measured only at one point in time. Therefore, stages of smoking determined in a cross-sectional study will yield heterogeneity among smokers who belong to the same stage. For example, experimental smokers can consist of those who have been experimental smokers for a long time, those who have reduced their level of smoking to experimental smoking recently, and those who are in the process of increasing a smoking level and will be regular smokers in the near future. Another problem with this research design is that it is impossible for researchers to determine a causal relationship. The use of a longitudinal design removes the above concerns. Thus, a longitudinal research design is a more relevant approach to understanding adolescent smoking, although this type of research is time-consuming and expensive (Hennekens & Buring, 1987). Despite the necessity of a longitudinal study, there is a paucity of these studies on adolescent smoking in the South Korean literature. The implementation of a longitudinal design is necessary to measure change in smoking accurately. In U.S. longitudinal studies, smoking definitions can be categorized into three groups (i.e., definitions based on stage models, smoking trajectories, and information available in data). Among the three, defining smoking behavior based on available information should be avoided because findings across studies cannot be compared. At the beginning stage of research, investigators must consider thoroughly how to define smoking behavior (e.g., stage models and smoking trajectories), and data must be collected based on this consideration.

Another important issue in definitions of smoking is that research should be based on repeated measures of smoking in order to take into account a time-dependent characteristic. In order to incorporate this issue in a study, a longitudinal study is necessary. In the U.S. literature, 2-time measures of smoking have been used widely. Recently, however, researchers have suggested the importance of measuring smoking behavior more than 3 times. These researchers stress that smoking behavior is time-dependent, and thus 2-time measures of smoking cannot capture completely the whole of these smoking trajectories. Park (2006) used three measures of smoking behavior to examine predictors of the transition from

experimenters to regular smoking among U.S. adolescents. The results showed that regular smokers were not homogeneous. After the subjects became regular smokers, some of them remained regular smokers at the third measure of smoking (i.e., current regular smokers), but the others reduced their cigarette use (i.e., former regular smokers). Compared to current regular smokers, former regular smokers were more conventional, which implies that they had a tendency to get less involved in problem behaviors such as marijuana, alcohol, and other illicit drug use. If smoking behavior had been measured twice, it would not have revealed the heterogeneity of regular smokers. This study demonstrated the significance of at least 3-time measures of smoking in research. Multiple measures of smoking behavior make it possible for researchers to divide smokers into homogeneous groups. The grouping of homogeneous smokers will enhance the intervention effects by allowing healthcare providers to use different strategies for each group rather than the same strategies for all smokers.

The final issue concerns the type of information that should be gathered for smoking measures. According to the South Korean literature, smoking measures may not precisely capture adolescent smoking behavior. Studies in South Korea have overlooked the examination of different types of smoking behavior, while focusing on differentiating smokers from non-smokers (focusing on current smokers). The heterogeneity of adolescent smokers has been proven through U.S. studies based on both stage models and smoking trajectories. Thus, it is necessary to investigate the heterogeneity of South Korean adolescent smokers in detail. To accomplish this, more detailed information (e.g., the regularity and amount of cigarette use) should be collected.

## CONCLUSION

Understanding adolescent smoking behavior is difficult because diverse factors affect smoking behavior and there is no consensus on the definition of adolescent smoking behavior. Despite this difficulty, the investigation of adolescent smoking behavior must continue so that researchers assist adolescents not to experience negative health outcomes due to smoking. Currently, definitions of smoking in the U.S. literature can be categorized into three types, that is, definitions based on theories, trajectories, and information available in data. Additionally, the review of South Korean studies sug-

gests the necessity of a longitudinal study design to understand the heterogeneity of smokers. For a better understanding of adolescent smoking behavior, it is essential to measure their smoking behavior accurately. First, repeated measures of smoking over time (i.e., longitudinal design) are necessary. Second, theory- or trajectory-based smoking definitions are more desirable than definitions derived from available data. Third, detailed information on both the regularity of smoking and the amount of cigarette use must be compiled and incorporated in defining adolescent smoking behavior in order to examine different levels.

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