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The impact of youth, family, peer and neighborhood risk factors on developmental trajectories of risk involvement from early through middle adolescence

Bo Wang¹, Lynette Deveaux², Xiaoming Li¹, Sharon Marshall¹, Xinguang Chen¹, and Bonita Stanton¹

¹Pediatric Prevention Research Center, Department of Pediatrics, Wayne State University, Detroit, Michigan, USA

²Office of HIV/AIDS, the Bahamas Ministry of Health, Nassau, The Bahamas

Abstract

Few studies have analyzed the development course beginning in pre-/early adolescence of overall engagement in health-risk behaviors and associated social risk factors that place individuals in different health-risk trajectories through mid-adolescence. The current longitudinal study identified 1276 adolescents in grade six and followed them for three years to investigate their developmental trajectories of risk behaviors and to examine the association of personal and social risk factors with each trajectory. Group-based trajectory modeling was applied to identify distinctive trajectory patterns of risk behaviors. Multivariate multinomial logistic regression analyses were performed to examine the effects of the personal and social risk factors on adolescents' trajectories. Three gender-specific behavioral trajectories were identified for males (55.3% low-risk, 37.6% moderate-risk, increasing, and 7.1% high-risk, increasing) and females (41.4% no-risk, 53.4% low-risk, increasing and 5.2% moderate to high-risk, increasing). Sensation-seeking, family, peer, and neighborhood factors at baseline predicted following the moderate-risk, increasing trajectory and the high-risk, increasing trajectory in males; these risk factors predicted following the moderate to high-risk, increasing trajectory in females. The presence of all three social risk factors (high-risk neighborhood, high-risk peers and low parental monitoring) had a dramatic impact on increased probability of being in a high-risk trajectory group. These findings highlight the developmental significance of early personal and social risk factors on subsequent risk behaviors in early to middle adolescence. Future adolescent health behavior promotion interventions might consider offering additional prevention resources to pre- and early adolescent youth who are exposed to multiple contextual risk factors (even in the

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Corresponding author: Bo Wang, Ph.D., Pediatric Prevention Research Center, Wayne State University School of Medicine, 4707 St. Antoine, Suite W534, Detroit, MI 48201, Phone: 313-966-2366, Fax: 313-745-4993, bwang@med.wayne.edu.

Ethics approval/Statement

The research protocol and questionnaires were approved by the institutional review boards at Wayne State University and The Princess Margaret Hospital in The Bahamas.

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absence of risk behaviors) or youth who are early-starters of delinquency and substance use behaviors in early adolescence.

Keywords

adolescent; sensation-seeking; parental monitoring; peer risk involvement; neighborhood risk; developmental trajectory; risk behaviors; The Bahamas

Introduction

A substantial literature has documented an increase of health-risk behaviors (i.e., delinquency, substance use, unsafe sexual behavior) during adolescence (Connell et al., 2009; Huang et al., 2012a; McMorris et al., 2007). This increase has been attributed to dramatic biological, cognitive, and social changes associated with this developmental period (Steinberg, 2008). The increases in sensation-seeking in early adolescence combined with immature cognitive control abilities have been postulated to play a primary role in adolescent health-risk behaviors (Steinberg, 2004). As a result of these developmental changes, adolescents frequently engage in multiple risk behaviors which have the potential to result in long-lasting negative health outcomes, including HIV infection and other sexually transmitted infections (Green & Ensminger, 2006; Millstein & Moscicki, 1995). Numerous educational programs, typically school-based, have been developed to reduce adolescent health-risk behaviors. However, systematic research on health education delivered to adolescents indicates that even the best programs have had modest success in altering adolescent engagement in unsafe practices (Steinberg, 2004).

Determination of distinctive trajectories of risk behaviors in adolescence and associated risk factors (i.e. factors associated with negative behaviors) may help in identifying subgroups of youth who are at greater risk and inform future prevention efforts. In the past decade, a growing number of studies have examined developmental trajectories among adolescents and young adults of specific unhealthy behaviors and risk factors that are associated with these trajectories; behaviors examined include alcohol use (Danielsson et al., 2010), delinquency (Miller et al., 2010), cigarette smoking (Tucker et al., 2006), marijuana use (Brook et al., 2011), and unsafe sexual behavior (Fergus et al., 2007; Huang et al., 2012b). These studies demonstrated that practising these potentially unhealthy behaviors tends to follow a limited number of distinct developmental pathways of specific behavior in adolescence. For example, using data from the 1997 National Longitudinal Survey of Youth, Huang and colleagues (2012b) identified five trajectories of unsafe sexual behavior from adolescence to young adulthood (including high-risk, decreased risk, increased-early, increased-late, and low-risk groups). Danielsson et al. (2010) described four developmental pathways of alcohol drinking in adolescence (including low, gradually increasing, high, and suddenly increasing consumption) among a cohort of high school students in Stockholm, Sweden. Tucker et al. (2006) identified six smoking trajectory groups among women from adolescence to young adulthood (stable highs, early increasers, late increasers, triers, decreasers, and abstainers) and found that women with certain patterns of smoking (stable highs and early increasers) are at increased risk for early sexual activities. All of the above-

mentioned longitudinal studies except for the study conducted by Miller and colleagues (2010) investigating the developmental trajectories of risk behavior identified youth in their mid-adolescence (at age 14 or 15 years) and followed them until late adolescence or young adulthood (age 19–25 years). It is probable that many of these youth were already involved in unhealthy behavior at the inception of prior studies. There is a lack of empirical research into the developmental course of risk engagement in early adolescent. Furthermore, as risk behaviors in adolescence are highly interrelated (Palen et al., 2006; Tu et al., 2012), it may be more informative to investigate the developmental course of overall risk behaviors in adolescence from a preventive perspective. Therefore, our study extends the work of the previous studies by examining the trajectories of overall health-risk behaviors from early through middle adolescence.

Multiple factors have been identified which increase or decrease the likelihood of young people performing health-risk behaviors. High sensation-seeking has been found to be associated with a range of unhealthy behaviors including delinquency (Harden et al., 2012), drug use (Kong et al., 2013), smoking (Hampson et al., 2013), alcohol use (Wilkinson et al., 2011), and unsafe sexual behaviors (Charnigo et al., 2012). Adolescent behavior is highly influenced by social factors such as parents and peers (Steinberg, 2004). Effective parental monitoring has been shown to reduce problem behavior among adolescents, including early sexual initiation, smoking and marijuana use, and unsafe sexual behavior (Coley et al., 2009; Stanton et al., 2004). Conversely, low levels of parental monitoring have been associated with increased levels of delinquent behavior, smoking, alcohol and drug use, and unsafe sexual practices (Caldwell et al., 2006; Dick et al., 2007; DiClemente et al., 2001). Parental monitoring is thought to mitigate adolescent unsafe behavior by limiting opportunities for adolescents to engage in these behaviors (including exposure to peers who engage in these practices) and creating an environment in which there is pressure for adolescents to comply with parental expectations (Sieverding et al., 2005). Perceptions of peers' unhealthy behaviors increase the likelihood that an adolescent will engage in similar activities (Arnett, 2007). For example, adolescents who perceive their friends to be using alcohol/drugs and having sex will engage in these behaviors more frequently than those who do not perceive their friends to be doing so (Aseltine, 1995; Romer & Stanton, 2003). Studies also found that, beyond family and peer contexts, social settings such as neighborhoods play an important role in unhealthy behaviors. Adolescents' perceptions of neighborhood disorganization such as violence and drug activity were associated with increased alcohol, tobacco and marijuana use (Lambert et al., 2004; Wilson et al., 2005), and early initiation of sexual activities for boy (Upchurch et al., 1999). Despite the abundant literature on adolescent health-risk behavior and contextual factors, we know relatively little about the combined impact of earlier youth, family, peer and neighborhood risk factors (e.g. during pre-adolescence) on the subsequent adolescent developmental course of unhealthy behaviors.

Accordingly, this study uses four waves of data from a longitudinal study to investigate the developmental trajectories of risk behaviors (i.e., reports of enacting health-risk behaviors regarding delinquent/aggressive behavior, substance use and unsafe sex) and associated contextual risk factors that put pre- and early-adolescents at elevated likelihood to follow the high-risk trajectories. The goals of the current study were threefold. First, we sought to

explore whether there are multiple trajectory patterns of risk behaviors among Bahamian adolescents from pre-/early through middle adolescence. Second, if such trajectories exist, we sought to describe growth patterns of specific risk behaviors for those who follow the high-risk trajectory. Finally, we examined the impact of different combinations of social/contextual risk factors on the probability of being in high-risk trajectory group.

Methods

Study site

The data was collected as part of a school-based, HIV prevention program in The Bahamas. The Bahamas was selected for the study because of its relatively high adult HIV prevalence rate (2.8%) in the Caribbean (UNAIDS, 2012). Fifteen government elementary schools (from among a total of 26 schools) on the main island of The Bahamas (New Providence) participated in this study. New Providence was selected as the study site because it is home to 65% of the nation's population, including an estimated 86% of those infected with HIV (Bahamian Ministry of Health, 2006). The youth in this sample represented approximately two-thirds of all youth in the 15 participating schools.

Participants

The study was carried out from September 2004 to December 2008 in 15 government elementary schools in The Bahamas. The original study was a three-arm HIV prevention intervention that included an attention control condition that was an environmental conservation course and two variations of an HIV adolescent risk reduction intervention. A detailed description of the intervention and control conditions can be found in our prior publications (Chen et al. 2009; Gong et al. 2009). The full cohort of youth was followed longitudinally for three years with follow-up rates of 95% at 12 months, 92% at 24 months, and 87% at 36 months post-intervention. This longitudinal study affords an excellent opportunity to study developmental trajectories of early risk involvement. The results from these follow-ups showed that the intervention significantly increased youth's HIV/AIDS knowledge, perceptions of their ability to use condoms and condom use intention among Bahamian preadolescents, but did not have a significant effect on delinquent and substance use behaviors or unsafe sexual behaviors including early sexual initiation and multiple sex partners which are the behaviors of focus in the present analyses (Chen et al. 2009; Chen et al. 2010; Gong et al. 2009). We compared proportions of youth in each developmental trajectory and found that distributions of trajectory group memberships are equivalent across the three randomized groups (two intervention and one control), overall or stratified by gender. Given the fact that group assignment was not associated with trajectory patterns of overall risk involvement, we included youth who were assigned to the two intervention groups as well as the control group. We excluded 84 youth who never filled out any follow-up surveys. The final sample size is 1276 (including 607 males). The data were obtained from four surveys of the youth [a baseline survey (Grade 6) and three post-intervention follow-up surveys conducted 12 months (Year 1), 24 months (Year 2) and 36 months (Year 3) after the intervention]. The mean age of youth at baseline was 10.4 years (range nine to 13 years). Ninety-nine percent of youth were of African descent.

Data collection procedures

Data were collected using the Bahamian Youth Health Risk Behavioral Inventory (BYHRBI), a paper-and-pencil questionnaire administered in the classroom setting (Deveaux et al., 2007). The instrument was adapted from the Youth Health Risk Behavioral Inventory (Stanton et al., 1995) through extensive ethnographic research and pilot testing. The questionnaire was read out-loud by project staff while the students marked their responses on the questionnaires, which required approximately 45 minutes to complete. Parents and students were informed that participation was voluntary, and their answers were confidential. Written youth assent and parent consent were required for participation in the study. Teachers were asked to leave the classrooms during the survey. Each student was given a voucher worth \$5 Bahamian after completing the survey. The research protocol and questionnaires were approved by the institutional review boards at Wayne State University and The Princess Margaret Hospital in The Bahamas.

Measures

Adolescent health-risk behaviors—Engagement in risk behaviors was assessed using the BYHRBI (Deveaux et al., 2007). Respondents were asked to report on whether they had engaged in various types of delinquent and aggressive behaviors, including whether they had been suspended, been truant, carried a knife, screwdriver or cutlass as a weapon and engaged in a fight in the past six months. The questions assessing youth engagement in substance use asked about cigarette smoking, alcohol consumption, marijuana use, and involvement in drug trafficking (selling or carrying drugs and being asked to sell drugs) over the past six months. In addition, sexual risk behavior was assessed by two questions including whether the youth had sex in the last six months and had two or more sexual partners in the last six months. In total, 11 risk behaviors were assessed. Examples of the questions used to assess risk behaviors include “In the last six months, did you carry a knife, screwdriver or cutlass to use as a weapon (yes/no)?”, “In the last six months, have you had a drink of alcohol, beer, wine, rum or bush rum or liquor (yes/no)?” and “Have you had sex in the last six months (yes/no)?” One point was assigned to each risk behavior in constructing the composite score for overall risk behaviors. The composite score ranged from 0 to 11, with higher scores indicating more risk behaviors.

Sensation-seeking—The level of sensation seeking was measured using the Brief Sensation Seeking Scale (BSSS-4) (Stephenson et al., 2003; Vallone et al., 2007). Sample items include “I like to do frightening things” and “I prefer friends who are exciting and unpredictable.” Responses to these items were based on a five-point Likert scale (1=strongly disagree to 5=strongly agree). Individual items were averaged to yield a scale score ranging from 1 to 5. The Cronbach alpha for the scale was 0.67. Sensation-seeking was further dichotomized into two categories using upper quartile as the cutoff for “*high sensation-seeking*” in the analyses.

Neighborhood risk—There are eight items in the questionnaire to assess the frequency of alcohol consumption, drug use and drug trafficking present in the student’s neighborhood environment (e.g., “how often have you seen a person who lives in your neighborhood drink alcohol?”). The students respond to the questions on a 3-point Likert scale (1=never to

3=very often). Individual items were averaged to yield a subscale score ranging from 1 to 3. The internal consistency for these items was 0.82. Neighborhood risk was further dichotomized into two categories using upper quartile as the cutoff for “*high-risk neighborhood*” in the analyses.

Peer risk behaviors—Peer risk was measured using 10 questions inquiring how many of the respondent’s friends who are about his/her age are having sex or drinking alcohol or using drugs. Sample questions included “how many of your close friends have sex?” and “how many of your friends drink alcohol?” Responses to these items were based on a three-point Likert scale (1=none to 3=most). Individual items were averaged to yield a subscale score ranging from 1 to 3. The Cronbach alpha for the scale was 0.77. Peer risk was further dichotomized into two categories using upper quartile as the cutoff for “*high-risk peers*” in the analyses.

Parental monitoring—A validated eight-item parental monitoring scale (Small & Kerns, 1993) was employed to assess youth perceptions of parents’ knowledge about their whereabouts and parents’ monitoring efforts. Sample items included “my parents/guardian know where I am after school” and “when I go out, my parents/guardian tell me what time I’m to return.” Responses to these items were based on a five-point Likert scale (1=never to 5=always). The internal consistency (Cronbach’s alpha) of the scale was 0.86. Individual items were averaged to yield a scale score ranging from 1 (low levels of parental monitoring) to 5 (high levels of parental monitoring). Parental monitoring was further dichotomized into two categories using the lower quartile as the cutoff for gender specific “poor parental monitoring” in the analyses.

Analysis

First, proportions of respondents engaging in specific behaviors at baseline and at each follow-up (years 1, 2, and 3) were computed and the proportions at different time points were compared using generalized linear mixed model (GLIMMIX) which takes into account the dependency of observations and clustering effect of school and/or classroom.

Group-based trajectory modeling (Nagin & Tremblay, 2001) was applied to identify distinctive trajectory patterns of risk behaviors among respondents enrolled in early Grade 6 and followed for three years, typically through Grade 9. The method assumes a mixture of subpopulations with different individual trajectories within the target population and identifies distinctive groups within which individuals share similar developmental trajectories (Nagin, 2005). The dependent variable was risk behavior score at Grade 6 (baseline) and then at one, two and three years follow-up (Year 1, Year 2 and Year 3). Trajectories of risk behaviors were estimated by a mixture-censored normal model with different numbers of trajectory groups (two to five groups). The model also included age and intervention group assignment as time-invariant covariates. Missing data was handled using full information maximum likelihood estimation. Goodness of model fit was evaluated by the Bayesian Information Criterion (BIC). The optimal model was selected on the basis of a reasonably high BIC value and interpretability of the distinctive trajectories.

Based on the selected models, we examined the differences among the identified trajectory groups in terms of personal and social risk factors at baseline (including age, sensation seeking, neighborhood, peer risk behaviors and parental monitoring) using the chi-square. Multinomial logistic regression analyses were performed to examine the combined effects of these personal and social risk factors on respondents' group membership of high-risk, increasing trajectories (Fountain et al. 2012; Legerstee et al. 2013). Odds ratios (ORs) and 95% confidence intervals were calculated. The final step of analysis extended the group-based trajectory modeling framework by examining the impact of one, two or all three of the social/contextual risk factors on the probability of group membership. Estimates of group membership probabilities for eight scenarios about the level and combination of the three predictor variables were calculated. The calculations show which risk factor or combinations of risk factors have greater impact on the probability of membership in the high-risk trajectory groups. Bar charts are drawn based on the results of probability estimates to visually display the proportion of respondents who would be placed in a high-risk trajectory group if the whole group were exposed to all or different scenarios of risk factors. This method of examining the impact of early determinants on memberships of different developmental trajectories is supported by the literature (Jones & Nagin, 2007). While logistic regression analysis would have enabled examining the impact of a specific risk factor on the probability of membership in a specified group relative to the no/low-risk group, this approach does not facilitate examining the impact of different scenarios of risk factors on the probability of group membership. All statistical analyses were performed using the SAS 9.2 statistical software package (SAS Institute Inc., Cary, NC, USA).

Results

1) Distinctive risk behavior trajectories

A series of group-based trajectory models were respectively fitted with a specification of 2 to 5 trajectory groups to determine the optimal number of trajectory groups. In trajectory analysis among males, the BIC value increased from BIC=-3518.25 in the two-trajectory model to BIC=-3472.56 in the three-trajectory model. The BIC value increased from BIC=-2760.56 in the two-trajectory model to BIC=-2740.98 in the three-trajectory model in female trajectory analysis. Estimations of the four- and five-trajectory models were not appropriately converged or resulted in very small trajectory groups (1.7% of sample). Consequently, the three-trajectory models were chosen for males and females as the optimal model to describe the study data.

The majority of the male sample was classified to the "low-risk" (55.3%) and "moderate-risk, increasing" (37.6%) groups. Only 7.1% of the male sample was classified to the "high-risk, increasing" group. The percent of correct group membership assignment was 88% for the "low-risk" group, 85% for the "moderator-risk, increasing" group, and 87% for the "high-risk, increasing" group. For female youth, 41.4% were classified to the "no-risk" group while 53.4% were classified to the "low-risk, increasing" group. Only 5.2% of the female respondents were classified to the "moderate to high-risk, increasing" trajectory group. The percentages of correct group membership assignment were 84%, 93%, and 87% for the three trajectory groups, respectively. According to the general guidance (i.e., 70%

correct assignment) proposed by Nagin (2005), the model with a 3-group solution provides a good group classification.

2) Engagement in risky behaviors from Grade 6 through three years follow-up

Respondents' engagement in delinquency, substance use and sexual risk behaviors at baseline (Grade 6) and at Year 1, 2 and 3 follow-ups are depicted in Table 1. For delinquent behaviors, the proportions of male adolescents who reported being suspended from school or carrying knife, screwdriver or cutlass as a weapon increased from 3% and 6% at baseline to 19% and 18% at Year 3 follow-up, respectively; for female adolescents, the percentages increased from 1.5% and 0.5% at baseline to 12% and 5% at Year 3 follow-up, respectively. Fighting among males and females decreased from 42% and 27% at baseline to 33% and 18% at Year 3 follow-up while truancy remained comparatively stable for both males and females. For substance use behaviors, alcohol use among males and females increased from 25% and 18% at baseline to 30% and 32% at Year 3 follow-up, respectively. Proportions of males who used marijuana, sold or carried drugs, and had been asked to sell drugs increased from 1–3% at baseline to 5–7% at Year 3 follow-up while proportions of females who were involved in drug use remained very low throughout the study period (0.2% to 2.2%). Cigarette smoking was low for both males and females (less than 5%) throughout the observation period. The proportion that reported having had sexual intercourse in the last six months increased about 14-fold for males from 2% at baseline in Grade 6 to 28% at Year 3 follow-up and for females from less than 1% at baseline to 9% at Year 3 follow-up. The proportion having multiple sex partners in the last six months was approximately 2% for males and 0.3% for females at baseline and 13% for males and 2.5% for females at Year 3.

3) Development trajectories of risk behaviors

Group-based trajectory model was used to identify distinctive developmental trajectories of risk behaviors. Three distinctive trajectories were identified for both males and females. The fitted trajectories for the three group models are displayed graphically Figures 1a and 1b.

The majority of males was classified into the low-risk trajectory group (55.3%), engaging in few risk behaviors across their early to middle adolescent years. Over one-third of males belonged to a moderate-risk, increasing trajectory group (37.6%). This subgroup exhibited a moderately high level of risk behaviors in Grade 6 (over one risk behavior), and increased over time, on average in Year 3, this subgroup had engaged in nearly three risk behaviors over the last six months. Only 7.1% of males were classified into the high-risk, increasing trajectory; this subgroup exhibited many risk behaviors in Grade 6 (nearly three risk behaviors), increased dramatically in the first year and continued to increase until the end of the observation period; in Year 3 an average male in this subgroup had engaged in seven of the total 11 measured risk behaviors in the last six months. Females likewise followed three trajectories: a no-risk trajectory contained 41.4% of females, a low-risk, increasing trajectory contained 53.4%, and a moderate to high-risk, increasing trajectory included 5.2% of females. Females belonging to the no-risk trajectory exhibited very few risk behaviors in Grade 6, risk behaviors declined in the first year and remained at a low level until the end of the three year observation period. Females in the low-risk, increasing trajectory group demonstrated relatively few risk behaviors in Grade 6 but risk behaviors progressively

increased during the observation period. Females belonging to the moderate to high-risk, increasing trajectory exhibited a moderately high number of risk behaviors which increased significantly over the second and third years. At Year 3, the females in this subgroup on average reported having engaged in nearly five risk behaviors in the last six months.

4) Growth patterns of specific risk behaviors for moderate-risk or high-risk groups youth

At baseline, males belonging to the high-risk, increasing trajectory (n=43) mainly engaged in delinquent and substance use behaviors. Specifically, 67.4% engaged in physical fighting, 62.8% drank alcohol, 23.3% carried a knife, screwdriver or cutlass as weapon, 20.5% were truant from school, and 20.9% reported that they had been asked to sell drugs. Sexual behavior increased dramatically during the early high school years. At baseline, 18.8% reported having had sexual intercourse in the last six months and 6% had multiple sexual partners. In contrast, 85.7% were sexually active and 35.3% reported multiple sex partners at the end of the observation period. Except for smoking which remained fairly stable, all other risk behaviors increased significantly over the course of the three years' follow-up. For example, carrying a weapon increased from 23.3% at baseline (Grade 6) to 76.4% at Year 3 and marijuana use increased from 7.1% at baseline to 45.7% at Year 3.

For females in the moderate to high-risk, increasing group (n=35), the rates of physical fighting, alcohol use and truancy at baseline were almost as high as male rates (55.9%, 54.3%, and 17.1%, respectively). However, the rates of other risk behaviors among moderate to high-risk, increasing females were much lower than males. The rate of sexual intercourse increased about 10-fold from 5.9% in Grade 6 to 50% at Year 3. Except truancy and drug trafficking behaviors, all other risk behaviors also significantly increased during the observation period. For example, being suspended from school increased from 2.9% at baseline to 42.3% at Year 3; carrying a weapon increased from 5.7% in Grade 6 to 50% at Year 3; smoking increased from 14.7% in Grade 6 to 34.4% at Year 3.

A high proportion of males in the moderate-risk group (n=228) engaged in delinquent behaviors and alcohol use in Grade 6. For example, 55.6% engaged in physical fight, 38.6% drank alcohol, 11.5% carried a weapon, and 7.8% were truant from the school. The rate of sexual intercourse increased about 20-fold from 2.4% at baseline (Grade 6) to 48.9% at Year 3. The rates of other risk behaviors including being suspended from school, carrying a weapon, alcohol use, marijuana use and being asked to sell drugs also significantly increased from baseline to Year 3 follow-up. For females belonging to the low-risk increasing trajectory (n=357), the rates of physical fighting and alcohol use were relatively higher in grade six (30.9% and 19.9%, respectively). The rates of being suspended from school, alcohol use and sexual intercourse significantly increased over the three years of follow-up.

5) Early determinants of development trajectories of risk behaviors

Table 2 summarizes adolescents' baseline characteristics by the three gender-specific trajectory groups and demonstrates the distributions of potential risk factors among the three trajectory groups. For males, older respondents were overrepresented in the moderate-risk and high-risk, increasing trajectory groups. For males, the moderate-risk and high-risk, increasing trajectory groups consisted of significantly higher proportions of adolescents who

were high sensation-seekers, lived in a high-risk neighborhood, had high-risk peer groups or reported poor parental monitoring compared to those in the low-risk group. For females, the moderate to high-risk, increasing trajectory group consisted of significantly higher proportions of adolescents who lived in a high-risk neighborhood or who had high-risk peers or who reported low parental monitoring compared to the no-risk group.

Table 3 shows the results of the multinomial logistic regression analyses regarding individual, family, peer and neighborhood factors in Grade 6 as predictors of developmental trajectories of overall risk behaviors over the subsequent three years. For males, group membership of the moderate-risk and high-risk trajectories was predicted by high sensation seeking, high-risk neighborhood and high-risk peers. Compared to males in the low-risk trajectory, males in the moderate-risk and high-risk, increasing trajectories were more likely to be high sensation seekers (OR=2.3, $p<0.01$; OR=4.5, $p<0.01$), to live in a high-risk neighborhood (OR=1.9, $p<0.01$; OR=3.2, $p<0.01$) or to have high-risk peers (OR=1.9, $p<0.01$; OR=3.0, $p<0.01$). In addition, males in the high-risk, increasing trajectory were more likely to report low parental monitoring compared to those in the low-risk trajectory (OR=3.1, $p<0.01$). For females, being in the moderate to high-risk trajectory was predicted by high-risk neighborhood and high-risk peers. Compared to females in the no-risk trajectory, females in the moderate to high-risk, increasing trajectory were more likely to live in a high-risk neighborhood (OR=2.6, $p<0.05$) or have high-risk peers (OR=3.3, $p<0.01$).

6) Impact of environmental risk factors on trajectory group probabilities

Figures 2a and 2b illustrate estimates of trajectory group probabilities for eight scenarios about the level and combinations of the three environmental risk factors: high-risk neighborhood, high-risk peers and low parental monitoring. Scenario 1 assumed no risk factors. This is equivalent to calculating trajectory group probabilities for individuals with none of the above risk factors for behaviors. Scenarios 2–4 assumed exposure to only one of the three risk factors, while scenarios 5–7 assumed exposure to two of the three risk factors. Scenario 8 assumed all three risk factors.

The results showed that each risk factor increased the probability of membership in the moderate-risk and high-risk, increasing trajectory groups for males. For example, in Scenario 2 (Figure 2a), the model predicted that the probabilities of being in the moderate-risk and high-risk, increasing trajectory groups for individuals who lived in high-risk neighborhoods but who have none of the other risk factors (i.e., high-risk peers and low monitoring) were 0.47 and 0.06, respectively. In contrast, the predicted probabilities of being in the moderate-risk and high-risk, increasing trajectory groups for individuals with no risks are 0.30 and 0.02, respectively. The presence of two or all three risk factors resulted in dramatic shifts. The probability of being in the high-risk group increased from 0.02 in the no-risk scenario to 0.14–0.17 in the three two-risk scenarios and to 0.31 in the three-risk scenario.

For females, high-risk peers and high-risk neighborhoods significantly reduced the probability of being in the no-risk trajectory and increased the probability of being in the moderate to high-risk, increasing trajectory. For example, in Scenario 3 (Figure 2b), the

model predicts that the probabilities of being in the no-risk trajectory and moderate to high-risk, increasing trajectory for individuals who have high-risk peers but who have none of the other risk factors were 0.33 and 0.14, respectively. In contrast, the predicted probabilities of being in these two trajectories for individuals with no risks were 0.40 and 0.04, respectively. The presence of two or three risk factors predicted high-risk behaviors. The probability of being in the moderate to high-risk, increasing trajectory increased from 0.04 in the no-risk scenario to about 0.20 in two of the three two-risk scenarios (high-risk peers plus high-risk neighborhood and high-risk peers plus low parental monitoring) and to 0.28 in the three-risk scenarios.

Discussion

In these Bahamian adolescents, there was significant heterogeneity in their developmental trajectories of risk behaviors from early through middle adolescence. The course of risk behaviors during this period was best described by three gender-specific trajectories. For males, over half engaged in constant low levels of risk behaviors, whereas the trajectories of others showed moderate or high risk behaviors which increased during the observation period. For females, one-third exhibited no risk involvement through the study period; two other trajectory groups showed low or moderate to high risk behaviors. While trajectory patterns were similar for both males and females, males in the moderate-risk and high-risk, increasing trajectories demonstrated a relatively greater number of risk behaviors and experienced faster increases in risk behaviors compared to their female counterparts in the corresponding trajectory patterns.

Our research differs from previous work by examining developmental pathways of overall risk behaviors in the early stages of adolescent development (pre/early adolescence through middle adolescence), which enables early identification of vulnerable adolescents. Our findings of a discrete set of diverse developmental risk trajectories are consistent with studies conducted among older youth (Danielsson et al., 2010; Huang et al., 2012b; Tucker et al., 2006). Our study expands upon previous research by examining the relative importance of different combinations of early risk factors on adolescents' subsequent risk behaviors using probability estimates. The calculations indicate that simultaneous exposure to multiple risk factors increased the level of risk behaviors for both males and females. However, there are important gender differences in early determinants. For males, the three social risk factors are almost equally important in predicting subsequent behaviors; for females, increased perception of peer risk behaviors (itself or in combination with other risk factors) demonstrated greatest influence on the moderate to high-risk trajectory.

The most problematic groups identified in the study were males in the high-risk, increasing trajectory and females in the moderate to high-risk, increasing trajectory, although these trajectories accounted for only 7% of the males and 5% of the females. This small subgroup of youth experienced a dramatic increase in risk behaviors during the observation period. Risk behaviors for males and females in these trajectories were seven and five risk behaviors, respectively, out of 11, in Year 3. Further, the high-risk, increasing trajectory respondents had early involvement in delinquency and substance use (physical fight, truancy, alcohol use) at baseline, and showed continuous engagement in other risk behaviors

including unsafe sex during the observation period. This finding is consistent with prior research indicating that youth who engaged in alcohol consumption and delinquency in middle adolescence are likely to engage in unsafe sexual behaviors in late adolescence (Guo et al., 2002; Miller et al., 2010). For this subgroup of high-risk adolescents with early multiple risk behaviors, prevention programs beginning as early as elementary school may be helpful. To be effective, such efforts might need to specifically address the confluence of increased sensation-seeking and immature cognitive abilities postulated to be of primary importance in adolescent health-risk behaviors (Steinberg 2004).

Over half the males demonstrated very few risk behaviors while over one-third of females exhibited almost no risk behaviors throughout the observation period. Thus a large group of adolescents did not engage in any risk behaviors from early through middle adolescent. The heterogeneity in developmental trajectories of risk involvement is associated with individual, family, peer and neighborhood risk factors at pre-adolescence. For males, high sensation-seeking, high-risk neighborhood environment, high-risk peer groups and low parental monitoring in grade 6 predicted multiple risk behaviors from early through middle adolescence. For females, engagement in multiple risk behaviors was predicted by a high-risk neighborhood and interaction with peers who exhibited multiple risk behaviors. Parental monitoring and sensation seeking in early adolescence did not predict girls' behaviors as it did boys'. We speculate that this difference may in part arise from the persistent high levels of parental monitoring of adolescent females but not males. Male sensation-seekers are to some extent granted more freedom as they enter middle adolescence while female sensation-seekers are watched carefully by their parents. Finally, we found that while a single predictor was associated with following a high-risk trajectory (especially among males), no single predictor was decisive in determining an individual's developmental course. Rather, it was the combination of two or three risk factors that predicted the high-risk trajectory. The presence of all three risk factors placed nearly one-third of males and over one-fourth of females in the high-risk, increasing trajectory; by the time this subgroup of youth completed early high school, an average male and female engaged in seven or five risk behaviors, respectively. This poses heightened risk for negative developmental outcomes (Green & Ensminger, 2006; Millstein & Moscicki, 1995).

Despite the significant findings of this study, several potential limitations should be noted. First, because we followed students only from early to middle adolescence, we do not know whether the identified trajectory patterns of risk behaviors will continue into late adolescence. Second, measures of risk behaviors relied on self-report. It is possible that adolescents under- or over-reported their behaviors due to social desirability or recall bias. Third, in developing the composite score of overall risk behaviors, we assigned the same weight to all behaviors, although arguably some behaviors may be less healthy in the short- and long-term. This strategy of creating a composite score of risk behaviors without differential weighting is supported by the literature (Bornovalova et al., 2008). Previous studies and data in the current study show high correlations among the risk behaviors studied here (Palen et al., 2006; Tu et al. 2012). Because levels of these behaviors are low at this age, we combined the three types of risk practices for the trajectory analysis. Fourth, we included youth who were assigned to the intervention groups in this trajectory analysis, which may have created some "noise" in the developmental trajectories. However, being in

a trajectory group did not differ by intervention groups. Further, we compared rates of 11 individual risk behaviors across the three intervention groups at baseline and three post-intervention follow-ups and found no significant differences among the intervention groups after controlling for baseline differences. Fifth, detailed information about the frequency and magnitude of each risk behavior would have been helpful in understanding the trajectory of adolescent risk behavior. However, this information was not collected in our study. Because our study participants are early adolescents and the rates of many risk behaviors were low, risk behavior questions were designed for yes/no responses. Finally, approximately 13% of youth were lost to follow-up at Year 3. We compared youth followed versus those lost to follow-up at Year 3 and found no significant differences in baseline risk factors and behaviors between the two groups except that higher proportions of respondents lost to follow-up reported physical fighting (40.7% vs. 23.9%, $p<0.05$) and alcohol consumption (26.9% vs. 20.4%, $p=0.05$) at baseline; those lost to follow-up were older and more likely to be male. Their attrition reduced the number of early high-risk males in the sample but possibly not predictors of trajectories.

In conclusion, the present study provides an empirical description of the developmental course of risk behaviors among pre- and early adolescent youth and demonstrates the cumulative impact of personality, family, peer and neighborhood risk factors on these behaviors. The study participants (grade 6 students) were recruited from 15 government elementary schools in the most populated island in The Bahamas. The developmental trajectories of risk behaviors represent youth living in an urban setting but may be applicable to a wider swath of adolescents living in urban settings across the Caribbean. Findings from this study have important implications for the development of prevention programs among adolescents.

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Research highlights

- Three gender-specific risk behavior trajectories were identified for male and female adolescents;
- Sensation-seeking, parental monitoring, neighborhood and peer risk factors predicted high-risk trajectory for males;
- High-risk neighborhood and peer risk predicted being in the moderate to high-risk trajectory group for females;
- The presence of all three social risk factors dramatically increased the probability of the high-risk trajectory.

Figure 1a

Figure 1b

Figure 1.

Figure 1a. Male adolescents' risk behaviors from early through mid-adolescence by trajectory group

Figure 1b. Female adolescents' risk behaviors from early through mid-adolescence by trajectory group

Figure 2.

Figure 2a. Impact of high-risk neighborhood, peer risk involvement and poor parental monitoring on group membership probabilities (Male)

Figure 2b. Impact of high-risk neighborhood, peer risk involvement and poor parental monitoring on group membership probabilities (Female)

Table 1

Proportions of respondents involved in risk behaviors from grade 6 to grade 9

Risk behaviors	Grade 6	Grade 7	Grade 8	Grade 9	t value
Male youth (n)	607	579	555	509	
1. Was suspended from school	3.4%	5.7%	10.8%	19.1%	9.20***
2. Was truant	6.0%	3.9%	3.9%	6.7%	0.11
3. Carried a knife/screwdriver	6.5%	7.3%	10.1%	18.0%	7.41***
4. Engaged in a fight	41.8%	33.5%	34.1%	33.3%	2.95**
5. Smoked cigarettes	2.5%	3.3%	4.5%	2.6%	0.73
6. Drank alcohol	25.2%	22.0%	24.0%	30.4%	2.86**
7. Used marijuana	1.3%	2.6%	4.7%	5.7%	4.93***
8. Sold or carried drugs	2.2%	1.7%	3.6%	4.6%	3.00**
9. Been asked to sell drugs	3.6%	3.8%	6.5%	7.5%	3.78***
10. Had sex in the last 6 months	2.1%	11.5%	19.9%	27.8%	14.80***
11. Had multiple sex partners	1.6%	4.8%	10.5%	12.8%	9.06***
Female youth (n)	669	633	617	599	
1. Was suspended from school	1.5%	2.6%	9.9%	12.0%	8.76***
2. Was truant	3.4%	1.6%	2.7%	3.2%	0.11
3. Carried a knife/screwdriver	0.5%	1.1%	2.0%	4.7%	5.79***
4. Engaged in a fight	26.7%	14.8%	16.4%	18.1%	3.96***
5. Smoked cigarettes	1.7%	1.1%	2.1%	2.4%	1.41
6. Drank alcohol	17.6%	12.6%	17.9%	31.8%	7.65***
7. Used marijuana	0.2%	0.2%	1.1%	2.2%	4.67***
8. Sold or carried drugs	0.3%	0.2%	0.5%	0.7%	1.25
9. Been asked to sell drugs	1.1%	0.5%	0.5%	1.9%	1.28
10. Had sex in the last 6 months	0.6%	2.1%	4.7%	8.9%	8.53***
11. Had multiple sex partners	0.3%	0.5%	1.1%	2.5%	4.01***

Note:

**
P<0.01;

P<0.001.

Table 2

Sensation-seeking, peer risk, parental monitoring and neighborhood risk factors at the beginning of the 3-year observation, by trajectory group

Variables	Males				Females					
	Overall	Traj.1 (336)	Traj. 2 (228)	Traj. 3 (43)	χ ²	Overall	Traj. A (277)	Traj. B (357)	Traj. C (35)	χ ²
Group membership (%)		55.3%	37.6%	7.1%			41.4%	53.4%	5.2%	
Age at baseline										
10 years old	57.8%	62.5%	54.4%	39.5%	8.69**	69.3%	74.0%	66.3%	61.8%	2.44
11 years old	32.8%	29.5%	35.1%	46.5%		24.4%	19.1%	27.8%	32.3%	
12 years old	9.4%	8.0%	10.5%	14.0%		6.3%	6.9%	5.9%	5.9%	
Intervention group										
Control	35.3%	36.9%	35.1%	23.3%	2.11	37.2%	39.0%	36.4%	31.4%	0.91
Intervention	64.7%	63.1%	64.9%	76.7%		62.8%	61.0%	63.6%	68.6%	
High sensation seeking										
No	75.7%	83.2%	68.3%	52.2%	16.48***	77.2%	76.7%	78.2%	70.8%	0.03
Yes (upper quartile)	24.3%	16.8%	31.7%	47.8%		22.8%	23.3%	21.8%	29.2%	
High-risk neighborhood										
No	73.3%	81.0%	66.2%	50.0%	27.45***	72.5%	77.8%	70.8%	48.6%	11.80***
Yes (upper quartile)	26.7%	19.0%	33.8%	50.0%		27.5%	22.2%	29.2%	51.4%	
Peer risk										
No	74.5%	82.6%	67.3%	47.6%	33.45***	75.7%	80.4%	74.9%	45.7%	13.52***
Yes (upper quartile)	25.5%	17.4%	32.7%	52.4%		24.3%	19.6%	25.1%	54.3%	
Low parental monitoring										
No	74.4%	78.4%	73.5%	46.3%	14.12***	75.1%	78.8%	73.8%	60.0%	5.68*
Yes (lower quartile)	25.6%	21.6%	26.5%	53.7%		24.9%	21.2%	26.2%	40.0%	

Note: For males: Group 1 = low risk group; Group 2 = moderate-risk, increasing group; Group 3 = high-risk, increasing group. For females: Group A = no risk group; Group B = low-risk, increasing group; Group C = moderate to high-risk, increasing group.

* $P < 0.05$;

** $P < 0.01$;

*** $P < 0.001$.

Table 3

ORs and 95% confidence intervals from multinomial logistic regression results showing correlates of high-risk and moderate-risk trajectories versus low/no-risk trajectory

Variable	Males (n=607)			Females (n=669)		
	moderate-risk vs. low-risk		high-risk vs. low-risk	low-risk vs. no-risk		Moderate to high-risk vs. no-risk
	OR	95% CI	OR	95% CI	OR	95% CI
Age						
10 years old (ref)	1.00					
11 years old	1.24(0.84~1.82)		1.60(0.76~3.36)	1.64(1.11~2.43) ^a	1.76(0.78~3.98)	
12 years old	1.46(0.78~2.72)		1.65(0.52~5.20)	0.89(0.46~1.71)	0.69(0.14~3.31)	
Intervention group						
Control	1.00					
Intervention	0.99(0.69~1.42)		1.87(0.83~4.17)	1.20(0.86~1.67)	1.60(0.73~3.50)	
High sensation seeking						
No						
Yes (upper quartile)	2.29(1.35~3.91) ^{**}		4.53(1.84~11.13) ^{**}	0.92(0.56~1.50)	1.36(0.52~3.53)	
High-risk neighborhood						
No	1.00					
Yes (upper quartile)	1.86(1.24~2.79) ^{**}		3.19(1.55~6.58) ^{**}	1.39(0.95~2.04)	2.60(1.21~5.56) [*]	
Peer risk						
No	1.00					
Yes (upper quartile)	1.94(1.27~2.95) ^{**}		2.99(1.44~6.23) ^{**}	1.14(0.76~1.71)	3.29(1.52~7.12) ^{**}	
Low parental monitoring						
No	1.00					
Yes (lower quartile)	1.13(0.74~1.72)		3.11(1.53~6.33) ^{**}	1.26(0.86~1.85)	1.88(0.87~4.03)	

Note:

* P<0.05;

** P<0.01.